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# EVALUATING A HAZARDOUS WASTE SITE

Examining the Potential  
for Migration of  
Contaminants



Submitted by  
Kimberly K. Stricklan  
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EVALUATING A HAZARDOUS WASTE SITE  
Examining the Potential for Migration of Contaminants

by

Kimberly K. Stricklan

A paper submitted in partial fulfillment  
of the requirements for the degree of

Master of Science in Engineering

University of Washington

November, 1991

Approved by \_\_\_\_\_

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## ACKNOWLEDGEMENTS

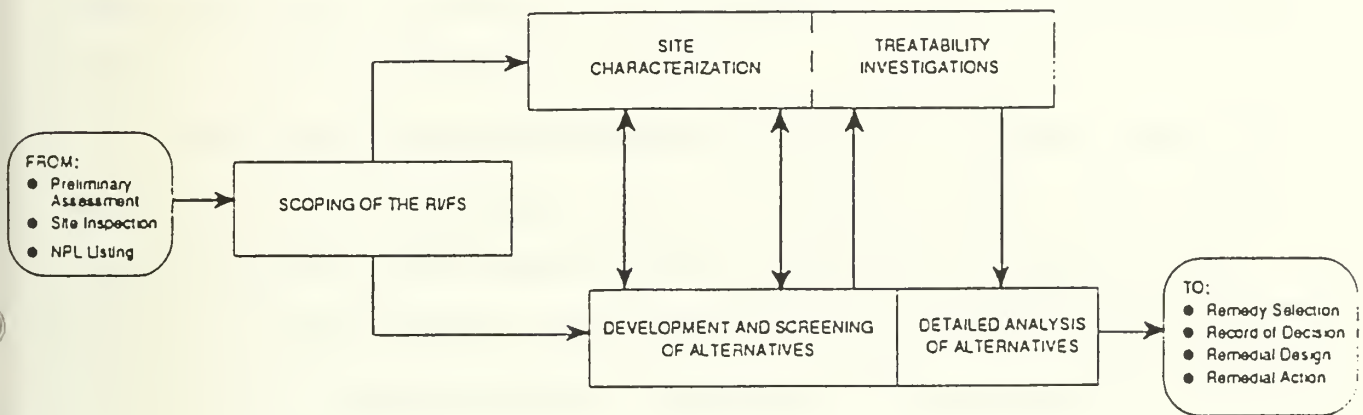
This research paper has truly been a joint effort. First on my list of appreciation is Professor H. David Stensel for the guidance in choosing a topic and seeing it through to the end. It was a long road, but we are really close. Professor Wen-Sun Chu provided the assistance with the groundwater computer model. For help in formatting this paper, I turned to a paper written by Robert Munger in 1987. He received his Master's Degree from UW, so I knew the form had to be somewhat correct. The raw data for the project was provided by the Environmental Engineering Division at Naval Submarine Base, Bangor. In particular, Patty Kelly, who spent endless hours answering questions and giving up her copies of data. Tom James and Beverly Pavliceck also deserve accolades. The computer graphics are courtesy of my husband, John, the AUTOCAD wizard; and my brother, Brad, did some of the coloring on the concentration grids.

All the strengths in this paper are the result of a group effort, credit for all the weaknesses lie with the author alone.



## INTRODUCTION

In 1980, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) was signed into law. It was later amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986. Under CERCLA (and modified by SARA), a National Priority List (NPL) of hazardous waste sites was established, along with specific guidelines for the clean-up of these sites.



**FIGURE 1** Remedial Investigation/Feasibility Study Process under CERCLA [5].

The clean-up process involves much more than just the actual site remediation work. As shown in figure 1, it includes everything from a preliminary assessment and initial inspection of the site, to remedial design and action. After scoping, shown as block two in the figure, the process is divided into two parts. The remedial investigation (RI) is conducted to characterize site conditions and conduct treatability





investigations. The other facet, the feasibility study (FS), is used to develop and screen possible remediation alternatives. As shown, the RI and FS are conducted concurrently. This is important because the data collected under the RI influences the development of remedial alternatives in the FS. Accordingly, the types of treatment being considered dictate what kind of data must be collected and analyzed in the RI [5]. The RI effort may cost hundreds of thousands of dollars and take 1 to 3 years to complete. This paper will focus solely on the site characterization evaluation requirements as part of the RI step leading to the clean-up process.

According to the Environmental Protection Agency (EPA) [5], there are four objectives in site characterization. They are conducting the field investigation, defining the nature and extent of contamination, identifying Federal/State contaminant and location specific ARAR's (Applicable or Relevant and Appropriate Requirements), and developing baseline risk assessments.

This study addresses the problem of determining the fate and behavior of contaminants at a hazardous waste site. The purpose was to determine the procedures required to assess the contaminants at a site and the factors that affect their transport. Limited available information about an existing hazardous waste site provided the necessary background to carry out the RI site characterization process. A brief qualitative assessment of the potential for environmental damage is also



provided.

Actual data on site characteristics and contaminants are needed to develop a practical evaluation of contaminant migration as part of an RI study. To satisfy this need, data from a hazardous waste site placed on the National Priority List in 1987 was used. This site is under the jurisdiction of the Department of Defense and specifically the U.S. Navy. It is located at the Naval Submarine Base in Bangor, Washington and is referred to as Site A. In this study, the following aspects of Site A were addressed:

1. The description and history, including physical features and a chronology of events leading to its placement on the NPL.
2. Information on the physical, chemical and biological behavior of the contaminants identified.
3. The surface water features of the site, including a surface runoff diversion facility.
4. The hydrogeological features, including data on five hydrogeologic zones located in the vicinity of Site A.
5. The distribution of contamination, including possible migration to neighboring communities.

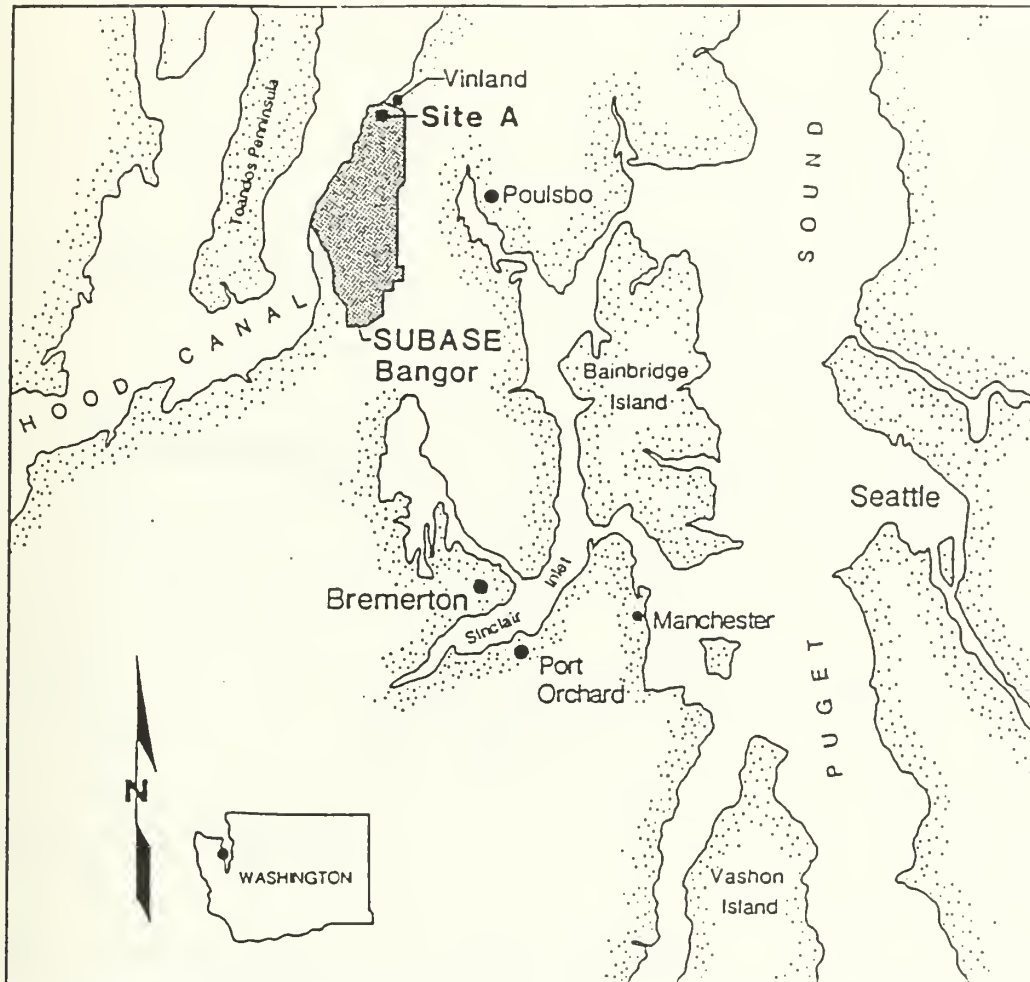
Finally, a groundwater flow computer model was applied to Site A to show various scenarios of contaminant migration.

#### DESCRIPTION AND HISTORY OF SITE A

The Bangor Naval Submarine Base (SUBASE Bangor) is located in the state of Washington, on the Kitsap Peninsula. As shown in



figure 2, it is approximately 10 miles north of Bremerton and 7 miles west of Bainbridge Island. Situated on the shores of the Hood Canal, it encompasses approximately 7000 acres of land.



Note: Base map prepared from "Puget Sound Country Washington" published by Kroll Map Company, undated.

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Scale in Miles

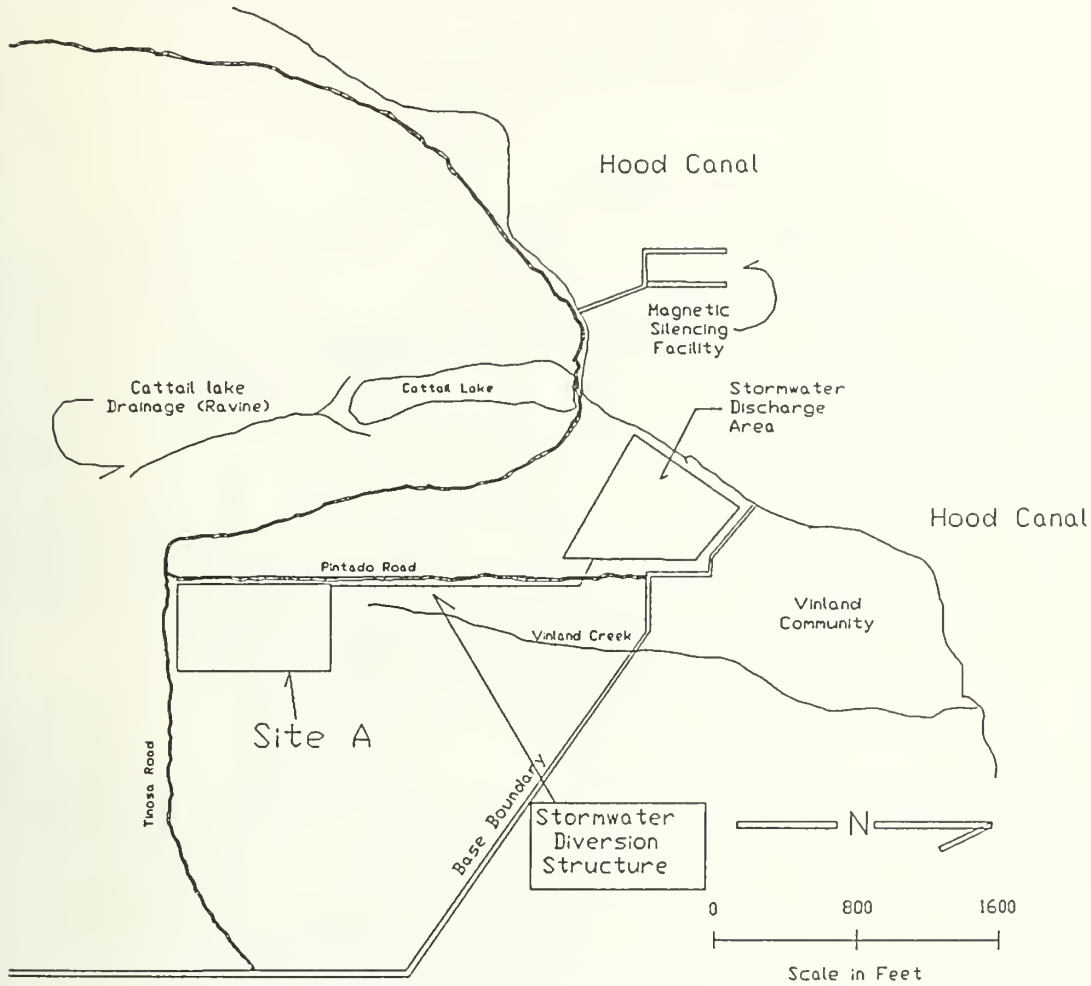
**FIGURE 2** Map of Kitsap Peninsula area [2].

Site A is located in the Northwest portion of SUBASE, at the intersection of Tinosa and Pintado Roads, about 1800 feet southeast of Cattail Lake, and 2100 feet southeast of the Hood Canal (figure 3). The closest neighboring community, Vinland, is located just outside the northern boundary fence, roughly 2800





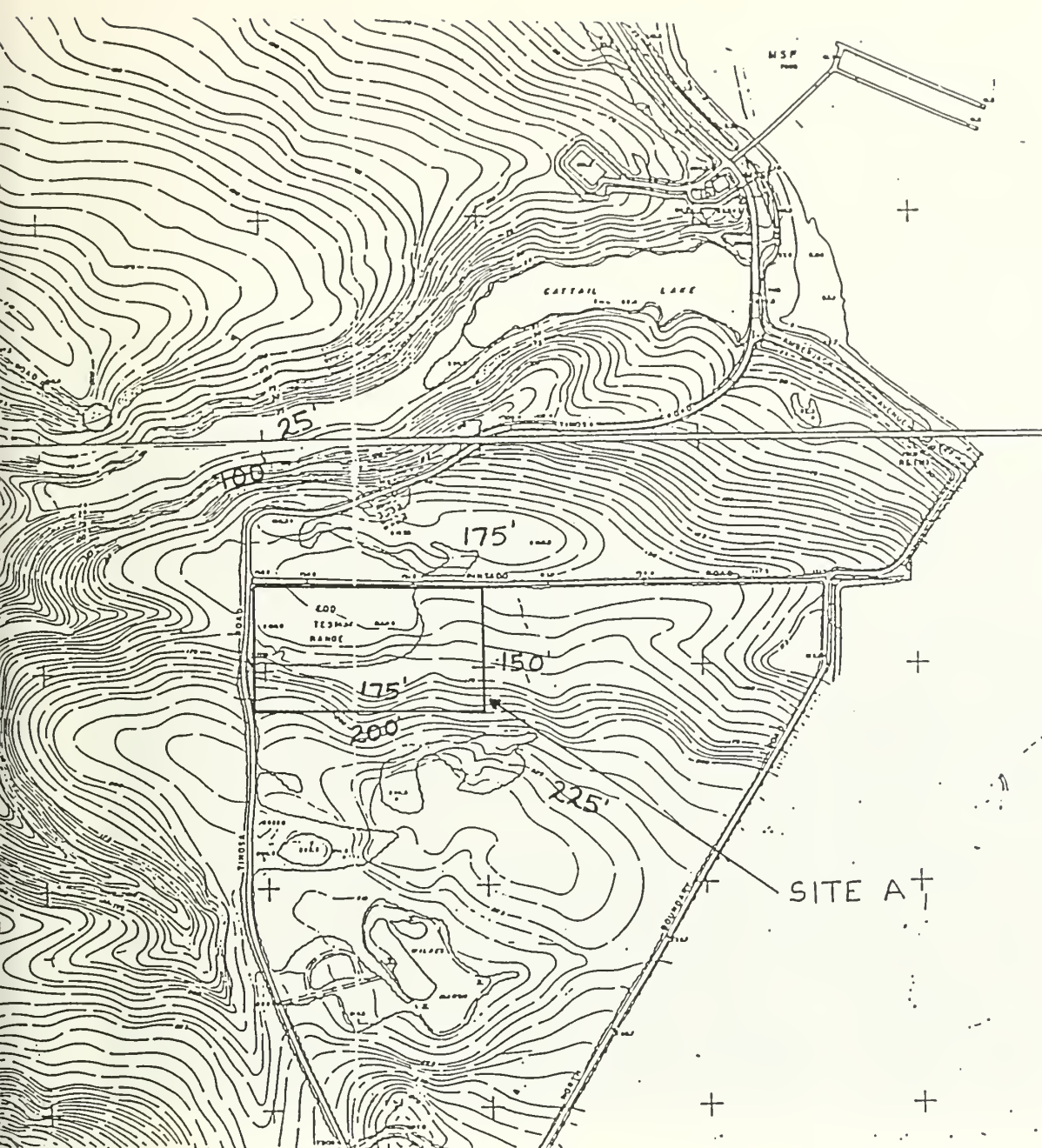
feet north of the site.



**FIGURE 3** Map of Site A and vicinity [2].

Site A is slightly sloped downward toward Pintado Road and is an upland site, located at an elevation of 150 to 180 feet. The topographical features of the site and the surrounding area are shown in figure 4. It is between 10 and 12 acres in size [7].





**FIGURE 4** Topographic map of Site A and vicinity.

Photographs of Site A are shown in figures 5 and 6. They show the southern end of the site, on the edge of Tinoso Road. Although all vegetation was removed during earlier operations, much of the vegetation has grown back. However, there are still some areas, particularly around the burn mounds, that have little or no vegetation.



Site A is surrounded by a security fence, which was done as an interim measure to limit direct access to the site. Although it is located in a restricted part of SUBASE, access to Site A itself is limited to personnel with specific Occupational Safety and Health Administration (OSHA) training. This restriction also applied to the author, who was not permitted access to the site.

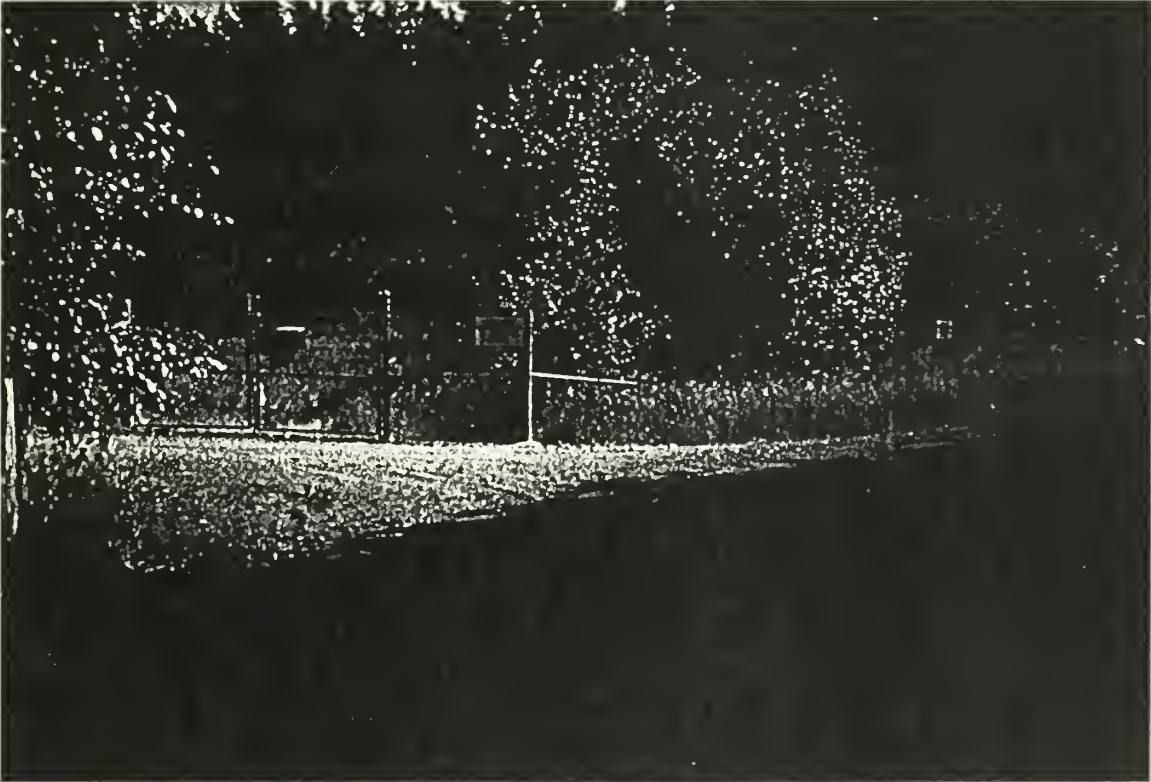


FIGURE 5 Photograph of Site A.





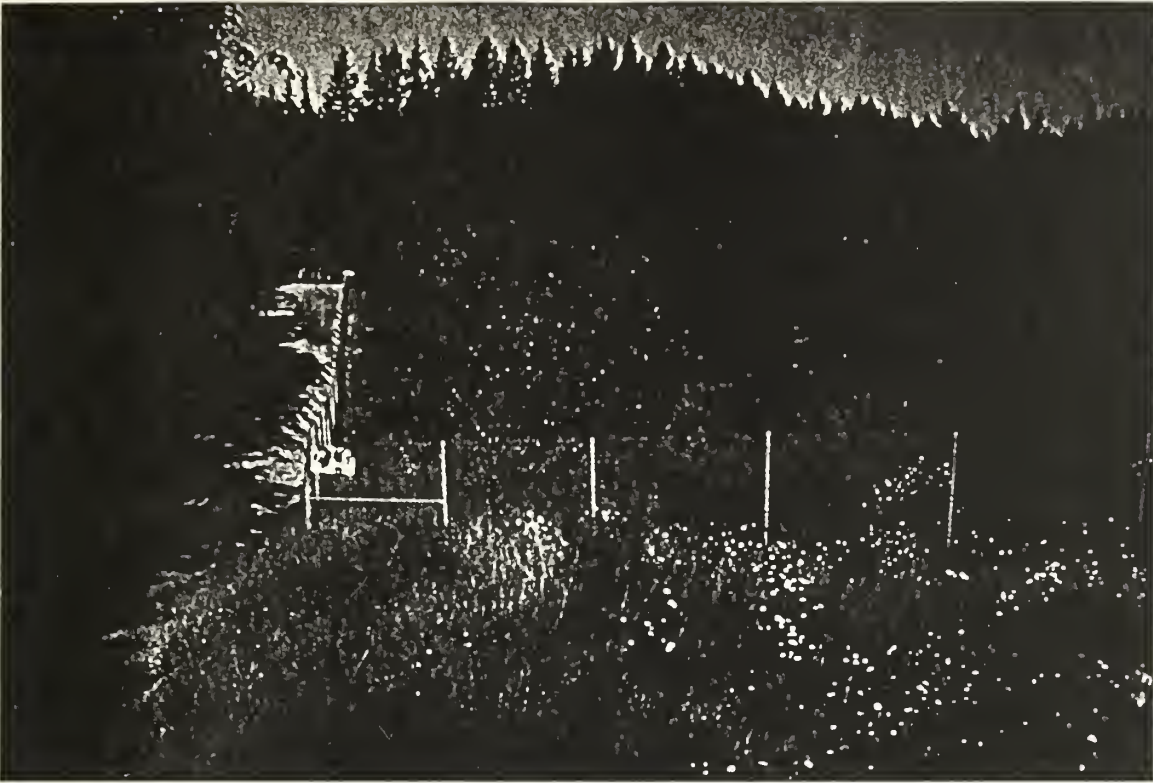


FIGURE 6 Photograph of Site A.

In 1944, a U.S. Naval Magazine Facility was established at Bangor and served as a transfer point. Fourteen years later, the disposal of ordnance was added to Bangor's mission. As a result, Site A was chosen as an ammunition burning and detonation site. It was used to burn TNT, flares, fuses, primers, smoke pots, smokeless powder, black powder, and other explosives [2]. Site A was also used as a storage site for barrels of "pink water", which is the condensate formed from steam cleaning operations involving TNT materials. It usually resulted from cleaning empty shell casings that previously contained TNT and other munitions compounds.

Disposal operations at Site A peaked between 1966 and 1970. However, in 1975 most of the activities conducted at Site A were



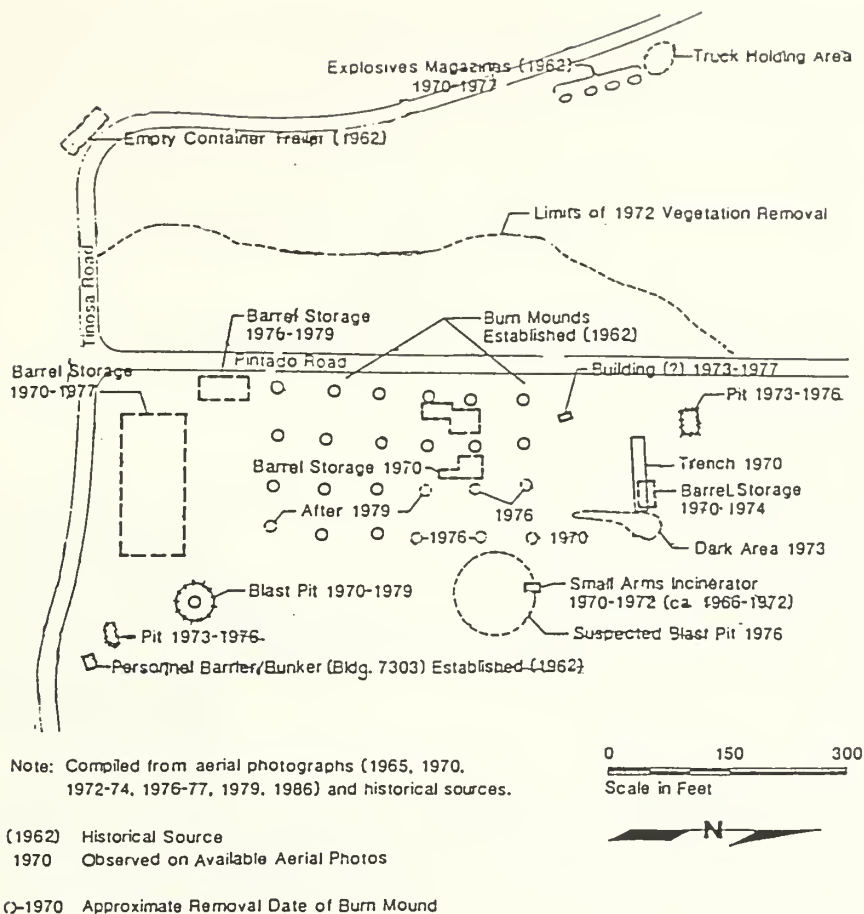


suspended due to concerns by the Navy about possible contamination as a result of U.S. Geological Survey reports. Two years later, the Navy began an Assessment and Control of Installation Pollutants (ACIP) program to evaluate their waste disposal sites, including Site A. For the next ten years, the Navy, under ACIP, collected several hundred soil and water samples from Site A and surrounding areas [2].

In 1987, the Navy ceased any further activity under ACIP due to the enactment of SARA by congress, and responded by phasing in the RI/FS program. In May of this year, the final RI/FS conducted on Site A was submitted to SUBASE Bangor. I decided not to obtain and read this report so that I could carry out an independent RI site evaluation, and relied on the Current Situation Report issued in 1988. A complete chronology of events leading up to the submission of the RI/FS is provided in appendix 1 [2].

Figure 7 summarizes the historical activities at Site A. The burn mounds, established in 1962 and later, were used for the disposal activities described above. The barrel storage areas were placed near the roads, on the edges of the site, to provide easy access for transport of the pink water to and from the site. The blast pit, used from 1970 to 1979, was shielded and used for TNT detonation. The incinerator in the lower right section of Site A was used for disposal of small arms and dangerous pyrotechnic items. Several other pits and trenches shown in the figure were used for burning or detonating various munitions [2].





**FIGURE 7** Map of Site A historical features [2].

Unfortunately, there is no accurate estimate of the amount of material that was disposed of at Site A. The amount was estimated from interviews and information in ordnance transfer documents. The resulting conservative estimate is that over two million pounds of munitions compounds were burned at Site A [7].

### CONTAMINANT CHARACTERISTICS

There are 9 potential "contaminants of concern" at Site A. Although numerous compounds were tested for at the site, these were chosen because they were obvious compounds used at the site and were detected above background levels. They are listed in table 1. In addition, Nitrogen, Copper, Mercury, Silver, and



Heptachlor were found at elevated levels, but are not related to any activities conducted at Site A. Because of the ambiguity associated with these contaminants, and lack of available data, they will not be discussed in this paper.

TABLE 1

CONTAMINANTS OF CONCERN AT SITE A [2].

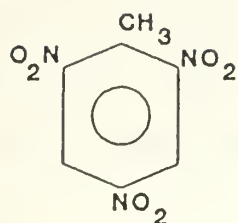
<u>Name</u>	<u>Symbol (if applicable)</u>
Zinc	Zn
2,4,6 Trinitrotoluene	TNT
2,4 Dinitrotoluene	2,4-DNT
2,6 Dinitrotoluene	2,6-DNT
1,3,5 Trinitrobenzene	1,3,5-TNB
Hexahydro-1,3,5 trinitro-1,3,5 triazine	RDX
Bis (2-ethylhexyl)phthalate	
Di-n-butylphthalate	
Di-n-octylphthalate	

The chemical structures of the organic materials are shown in figure 8. In the following subsections, important physical, chemical, and biological characteristics (including known ARARs), the possible effect on humans after exposure, and the potential for biodegradation will be discussed for each contaminant.

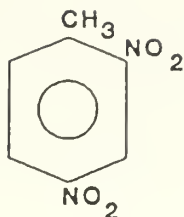
Zinc

Zinc is an abundant, naturally occurring, metal in the environment. However, it was designated as a contaminant of concern because of the high concentrations found at Site A. Levels as high as 180 mg/kg were found in soil samples and the highest water concentration detected was 0.87 mg/l, well above background levels.

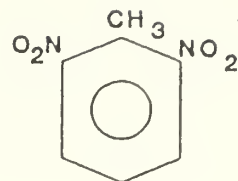




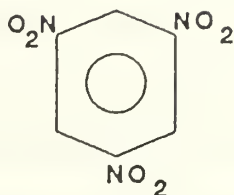
2,4,6-TNT



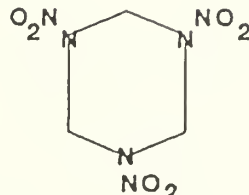
2,4-DNT



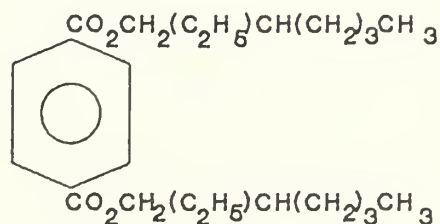
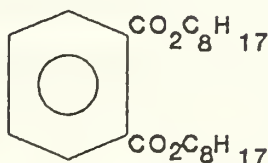
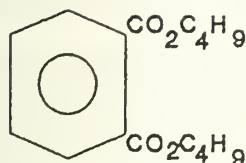
2,6-DNT



1,3,5-TNB



RDX



## PHTHALATES

DI-N-BUTYL

DI-N-OCTYL

BIS(2-ETHYLHEXYL)

**FIGURE 8** Chemical Structures of Contaminants of Concern [4,10].

Zinc, usually in solid form, has a strong tendency to sorb onto both organic and inorganic soil particles. However, some intermediate zinc complexes have been detected in water and are relatively non-reactive with solids. These forms tend to remain soluble for considerable periods of time. Because of its strong affinity for solids, zinc migrates primarily by particulate





transport associated with erosion [2].

Zinc is a required nutrient for human development, but in extremely high doses, can be detrimental. The drinking water standard for taste and odor control of zinc is 5 mg/L.

#### 2,4,6-TNT

2,4,6 trinitrotoluene, or TNT, is a flammable solid which exists in commercial form as yellow monoclinic needles. Although used as an explosive, TNT is highly stable at room temperature. It is relatively non-volatile, and therefore not easily hydrolyzed. The solubility of TNT is 130 mg/L, and its tendency to sorb onto solids is moderate with a partition coefficient of between 10:1 and 20:1. This coefficient, used for all contaminants, called  $K_d$ , an empirical soil:water distribution coefficient. It represents the ratio of mass of compound per unit mass of soil to the mass of compound per unit mass of water. Therefore, the higher the ratio, the greater the tendency to sorb to solids, and the lower the migration potential of that compound in groundwater.

The effects of TNT on humans, found from occupational exposure, include toxic hepatitis, aplastic and hemolytic anemia, gastrointestinal disruptions, contact dermatitis, and cataracts. The effects on the blood system can include hemolysis of red cells and hemoglobin in the blood stream [2]. There is no data available about TNT carcinogenicity. As a final note, TNT is also known to be toxic to various forms of aquatic life, including certain species of green algae, oyster larvae, fathead



minnows, and bluegills [2].

The primary form of degradation in the natural environment is photolysis. In fact, the half-life in natural sunlight can be as low as three hours. Although TNT is susceptible to degradation under natural conditions, it can persist in the environment for long periods of time. Accordingly, biodegradation by bacteria or fungal species is slow. However, biodegradation could be accelerated if an alternate carbon source were available [2]. Since this is not the case at Site A, an outside carbon source would be required if this method of treatment was being considered.

TNT biodegradation by *Phanerochaete chrysosporium*, or white rot fungi has been studied by Fernando et al [3]. In this study, the initial concentrations of TNT were set to 10,000 mg/kg in soil and 100 mg/L in water. The results of the study, for both soil and water, are shown in table 2.

Overall approximately 85% of the initial TNT was degraded, with about 19% of the carbon appearing as carbon dioxide in 90 days. A low nitrogen to carbon ratio, in the range of 1 to 11 is an important requirement for TNT degradation by white rot fungi. This may be difficult to maintain under actual environmental conditions since nitrogen is released during the degradation process.

At Site A, the Total Kjeldahl Nitrogen (TKN) in the soil averages around 1500 mg/kg [7]. Therefore, the nitrogen to carbon ratio is much higher than that in the study. The high



TKN, in addition to the nitrogen released during TNT degradation, would further limit the success of using Phanerochaete Chrysosporium. Thus, while white rot fungi shows promise for TNT degradation, it might not be a good biological degradation choice for use at Site A.

TABLE 2

RESULTS OF BIODEGRADATION STUDY ON 2,4,6-TNT [3].

Soil Samples:

<u># of days</u>	<u>Amount of TNT degraded</u>
30	49.2%
60	70.7%
90	87.7%

Water Samples:

<u># of days</u>	<u>Amount of TNT degraded</u>
30	77.9%
60	85.1%
90	87.7%

2,4-DNT and 2,6-DNT

Both 2,4 DNT and 2,6 DNT exist as pale yellow crystals of various structure, and are major constituents of pink water and a product of TNT photodegradation [2,4].

Volatility of both materials is extremely low and their solubility is high. The solubilities of 2,4-DNT and 2,6 DNT are 270 mg/L and 180 mg/L. The sorption coefficient (Kd) for both isomers is low, with a soil to water ratio of only 2:1 to 4:1 for each substance [2].



Studies have shown that exposure to 2,4-DNT can cause neuromuscular effects, central nervous system and liver lesions, weight loss, anorexia, anemia, and testicular atrophy. Studies conducted on munitions plant workers in the 1950's showed that cyanosis, dizziness, sleepiness, headache, dyspnea, and brown urine were among the results of repeated exposure to DNT [2]. Health criteria does exist for 2,6-DNT as a potential carcinogen. The 2,4 isomer is a potential carcinogen as well, but the only existing standards are based on 2,6-DNT.

Both forms of DNT readily degrade in anaerobic environments, providing there is an external carbon source present. Degradation products include aromatic diamines, aminonitrotoluenes, and nitrosonitrotoluenes. As with TNT, the primary form of degradation in the natural environment is photolysis. The average half-life is between 9.5 and 11.5 days. One intermediate product is 2,4 dinitrobenzoic acid, with end-products of carbon dioxide, water, and nitric acid resulting [2].

#### 1,3,5-TNB

1,3,5-TNB, a known constituent in TNT wastewaters, has a yellow crystalline structure in pure form. It is a high explosive with more shattering power and less sensitivity to impact than TNT, but is no longer widely used in munitions. Limited studies have shown that 1,3,5-TNB is mutagenic to microorganisms, but very little is known about the compound itself [2].

#### RDX





A major contaminant of concern at Site A is hexahydro-1,3,5 trinitro-1,3,5 triazine, or RDX. This substance is a white crystalline high explosive, which is a primary component used in C-4 plastic, as well as in the manufacture of other munitions.

Similar to TNT, RDX is relatively non-volatile. Water solubility ranges from 8 to 45 mg/L. Of all the contaminants of concern, RDX has the lowest K<sub>d</sub> value, in the range of only 1:1 to 2:1. As a result, RDX has the greatest tendency to migrate through groundwater. This is one reason the groundwater concentrations of RDX at Site A and vicinity were detected while other contaminants were not [2].

RDX appears to be sorbed through the stomach, and by inhalation through the lungs. Following adsorption, it seems to quickly metabolize within the liver into products such as inorganic carbon or formic acid. However, RDX is considered toxic to laboratory animals. In recent studies, exposure to RDX caused several reactions including convulsions, hepatotoxicity, anemia, splenic and urogenital lesions, prostate gland inflammation, and a variety of biochemical changes. Although it has been tested for carcinogenicity, the results were inconclusive [2].

Photolysis is the primary form of degradation in the natural environment, with a half-life of 1 to 12 days. However, it should be noted that TNT tends to retard the degradation rate. The end products of photolysis include formaldehyde, nitrate, nitrite, and ammonia. Another form of degradation that has met



with some success is thermal decomposition. RDX has also been known to biodegrade in a nutrient rich, anaerobic environment. The end-products for this process include formaldehyde, methanol, and hydrazine [2].

### Phthalates

Three such compounds, di-n-butylphthalate, di-n-octylphthalate, and bis(2-ethylhexyl)phthalate (BEHP) are included as contaminants of concern at Site A. Phthalates are colorless liquids used as plasticizers in the production of polyvinyl chloride (PVC).

Phthalates are also non-volatile, with a vapor pressure as low as  $6.8 \times 10^{-8}$  mm Hg. Solubility is low, in the range of .4 to 4.5 mg/L. The phthalates have the highest soil partitioning coefficient with a  $K_d$  ranging from 100:1 to as high as 10,000:1. Therefore, these compounds tend to remain in the soil and should not migrate well through surface or groundwater. Exact soil concentrations showing this phenomena will be shown later. The primary mechanism for loss is through hydraulic export in surface and groundwater [2].

Phthalates are readily sorbed in the intestinal tract and the lungs. Elevated levels of phthalates in the blood stream have been documented after ingestion of food that has been in contact with flexible plastics. One of the greater concerns for human exposure to phthalates appears to be from PVC bags and tubing used when treating dialysis patients. Although BEHP is considered an animal carcinogen, in general, data is inconclusive



program addressed possible contamination in soil, both surfacial and subsurface; water, both groundwater and surface runoff; vegetation; and shellfish. Each media will be addressed separately.

### Soil

Between 1977 and 1986, numerous surface and core samples were taken from Site A and the surrounding vicinity. Figure 9 shows selected surface and subsurface sampling locations for the contaminant data, summarized in tables 4 and 5. As shown in the figure, the majority of the samples were taken directly from the site, or from an off-site area toward Cattail Lake Drainage. Surface sample areas are noted by the citation, A-SS\*\*. Core samples are noted with the same designation as monitoring wells, or MW\*\*. Sediment samples from Cattail Lake and the Hood Canal are represented by the designation SW\*\* [2,7].

Tables 4 and 5 show the contaminant concentrations found at the various sampling locations, both at the site and the surrounding areas. Looking at Table 6 first, the highest concentrations are limited to the surface soil. In particular, there are elevated concentrations in samples taken from A-SS03 through A-SS05, which are located directly on the burn mounds. This is expected since the highest level of activity occurred at the burn mounds. TNT is the most concentrated contaminant, at levels ranging from 180 to 420 mg/kg in these areas. In the subsurface samples, most pollutants that were detected at all occurred at low levels and were found at MW-38. Since the



monitoring well was drilled directly on one of the burn mounds, these concentrations could be the result of the materials leaching into the subsurface soil from the burn mounds. In this table, the only contaminant found at high levels in both surface and subsurface samples was zinc. This could be due to possible elevated background levels of this material in the area.

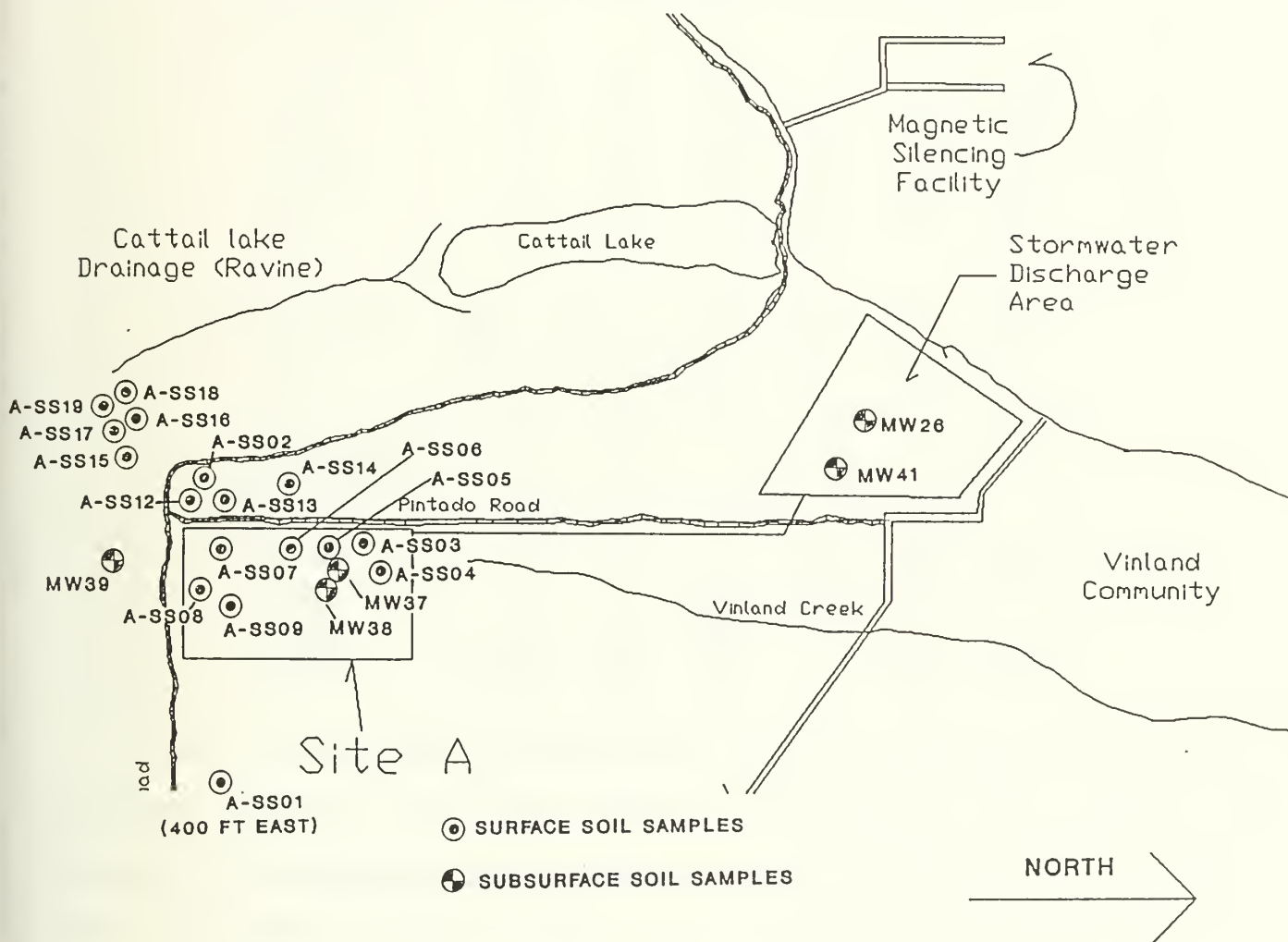


FIGURE 9 Soil Sample Location Plan [2].





TABLE 4

SOIL SAMPLE CONCENTRATIONS AT SITE A [7]  
(All concentrations are in mg/kg)

## Samples at Site A:

Surface samples:	A-SS03	A-SS04	A-SS05	A-SS06	A-SS07	A-SS08	A-SS09
Zinc	43	88	53	188	68	46	47
Di-n-butyl phthalate	0	0	0	0.15	0.22	0	0
Bis(2-eh)phthalate	0	0	0	0	0	0	0
Di-n-octyl phthalate	0	0	0	0	0	0	0
2,4,6-TNT	188	258	428	1.1	1.5	0.78	218
2,4-DNT	14	0.45	0.56	0.087	0.12	0.094	0.37
2,6-DNT	0.97	0.053	0.077	0.009	0.009	0.006	0.04
1,3,5-TNB	0	0.66	0.67	0.015	0.025	0.012	0.44
RDX	1.3	1.5	0	0.34	0.096	0.047	0.6

Subsurface samples: depth:	MW-37 (28 ft)	MW-37 (76 ft)	MW-38 (3 ft)	MW-38 (18 ft)	MW-38 (18 ft)	MW-38 (23 ft)
Zinc	45	24	44	32	27	48
Di-n-butyl phthalate	0	0	0	0.066	0	0
Bis(2-eh)phthalate	0	0	0	0	0	0
Di-n-octyl phthalate	0	0	0	0	0	0
2,4,6-TNT	0	0	1	0.079	0.086	0.059
2,4-DNT	0	0	0.004	0.001	0.002	0.002
2,6-DNT	0	0	0.006	0	0	0
1,3,5-TNB	0.002	0.002	0.009	0	0.002	0.003
RDX	0.092	0.048	0.074	0	0.047	0.004

Table 5 shows the concentrations in samples taken from areas adjacent to Site A. In these areas, contamination also appears to be limited mainly to the surface soil, but at much lower levels than those found at the site. No contaminants were found at levels above 0.25 mg/kg, with one exception. At A-SS15, the TNT concentration was 60 mg/kg. Since this does not correspond to with the other data found in these areas, it could be a bad data point. Again, zinc was found at elevated levels in both



surface and subsurface samples.

TABLE 5

SOIL SAMPLE CONCENTRATIONS ADJACENT TO SITE A [7]  
(All concentrations are in mg/kg)

Samples Adjacent to Site A:

Surface samples:	A-SS01	A-SS02	A-SS12	A-SS13	A-SS14	A-SS15	A-SS16	A-SS17	A-SS18	A-SS19
Zinc	42	43	0.037	0.035	0.046	1.7	0.044	0.29	0.03	0.033
Di-n-butyl phthalate	0	0	0	0	0.096	0	0	0.57	0.14	0
Bis(2-eh)phthalate	0	0	0	0	0.11	0	0	0.76	0.14	0
Di-n-octyl phthalate	0	0	0	0	0.096	0	0	0.13	0.14	0
2,4,6-TNT	0.26	0	0	0	0.013	60	0.13	0.061	0.086	0
2,4-DNT	0.004	0	0.029	0.035	0.014	0.85	0.017	0.033	0.029	0.019
2,6-DNT	0	0	0	0	0	0	0	0	0	0
1,3,5-TNB	0	0	0	0	0	1.2	0	0	0	0
ROX	0.058	0	0.032	0.025	0.026	0.99	0.02	0.055	0.02	0.03

Subsurface samples: depth:	MW-26 (1 ft)	MW-26 (3 ft)	MW-26 (5 ft)	MW-39 (3 ft)	MW-39 (12 ft)	MW-41 (1 ft)	MW-41 (3 ft)
Zinc	24	23	24	23	35	22	20
Di-n-butyl phthalate	0	0	0	0	0	0	0
Bis(2-eh)phthalate	0	0	0	0	0	0	0
Di-n-octyl phthalate	0	0	0	0	0	0	0
2,4,6-TNT	0.005	0	0	0	0	0.004	0.005
2,4-DNT	0	0	0	0	0	0	0
2,6-DNT	0	0	0	0	0	0	0
1,3,5-TNB	0	0	0	0	0	0	0
ROX	0.003	0.002	0	0.003	0.004	0.043	0.053

One last area to address regarding soil contamination is the possible accumulation of pollutants in the sediments of Cattail Lake and the Hood Canal. Samples were taken from both areas and are shown in Table 6. As shown, zinc was the only contaminant of concern discovered. The concentrations of zinc found in Cattail Lake were 3 times as high as those found in the Hood Canal, and higher than almost all samples taken at Site A. Again, this



could be due to elevated background levels of zinc. This also holds true for the Hood Canal samples. To establish reference or background levels of contaminants, sediment samples were taken at various areas around the Hood Canal, some at a considerable distance from SUBASE Bangor. These samples also showed elevated concentrations of zinc. Therefore, it appears that the activities conducted at Site A did not contribute to the zinc levels found in the Hood Canal sediments.

TABLE 6

HOOD CANAL SEDIMENT DATA  
(All concentrations are in g/kg)

sample location:	SW-10	SW-11	SW-12
Zinc	20	21	18
Di-n-butyl phthalate	0	0	0
Bis(2-eh)phthalate	0	0	0
Di-n-octyl phthalate	0	0	0
2,4,6-TNT	0	0	0
2,4-DNT	0	0	0
2,6-DNT	0	0	0
1,3,5-TNB	0	0	0
RDX	0	0	0

CATTAIL LAKE SEDIMENT DATA  
(All concentrations are in mg/kg)

sample location:	SW-15	SW-16
Zinc	63	89
Di-n-butyl phthalate	0	0
Bis(2-eh)phthalate	0	0
Di-n-octyl phthalate	0	0
2,4,6-TNT	0	0
2,4-DNT	0	0
2,6-DNT	0	0
1,3,5-TNB	0	0
RDX	0	0



Overall, contamination in the soil is generally restricted to the surface, particularly in the burn mounds. Otherwise, contaminants were found at low concentrations, if detected at all. Zinc is the only material found at elevated levels throughout the area.

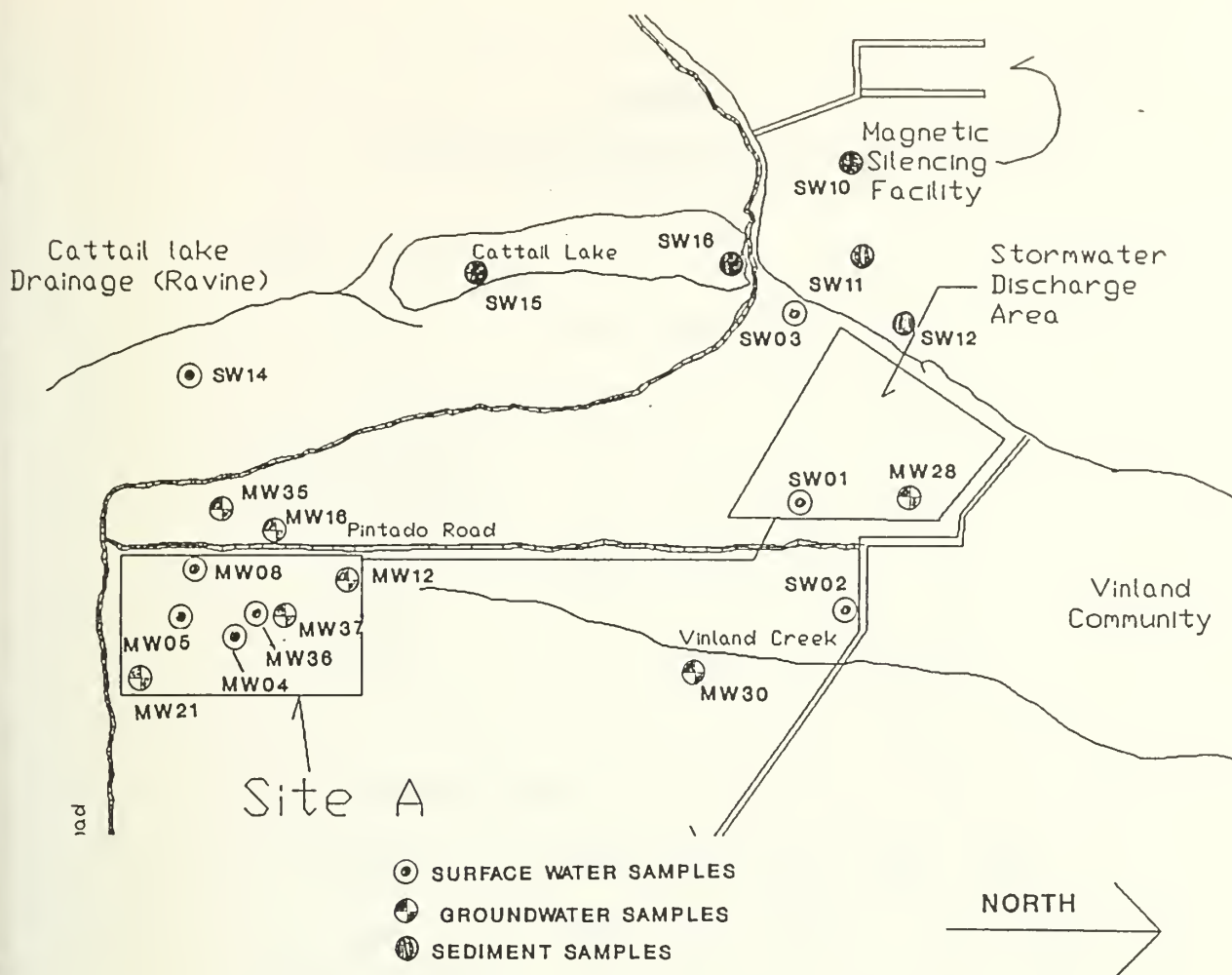
### Water

Numerous water samples have also been collected from Site A and the surrounding area. Figure 10 shows the location of selected groundwater and surface water sampling. Surface water samples were taken from monitoring wells drilled to a depth of only 2 to 5 feet, penetrating only the water zone contained on the surface. Sample locations for plant and shellfish tissue analysis are also shown on this map [2].

Surface water concentrations, taken at Site A and vicinity will be examined first, and are shown in table 7. The first part of the table shows the concentrations found at 4 monitoring wells directly on the site. As shown, the only consistent contaminant detected was TNT, with a high level of only 0.36 mg/l found at MW-04.







**FIGURE 10** Surface and Groundwater sample plan [2].



TABLE 7

SURFACE WATER CONCENTRATIONS AT SITE A AND VICINITY (7)  
(All concentrations are in  $\mu\text{g/l}$ )

## Samples at Site A:

location:	MV-04	MV-05	MV-08	MV-36
Zinc	0	0	0	0.004
Di-n-butyl phthalate	0	0	0	0
Bis(2-eh)phthalate	0	0	0	0
Di-n-octyl phthalate	0	0	0	0
2,4,6-TNT	0.36	0.002	0.003	0
2,4-DNT	0	0	0	0
2,6-DNT	0	0	0	0
1,3,5-TNB	0	0	0	0
RDX	0	0	0	0.002

## Samples adjacent to Site A:

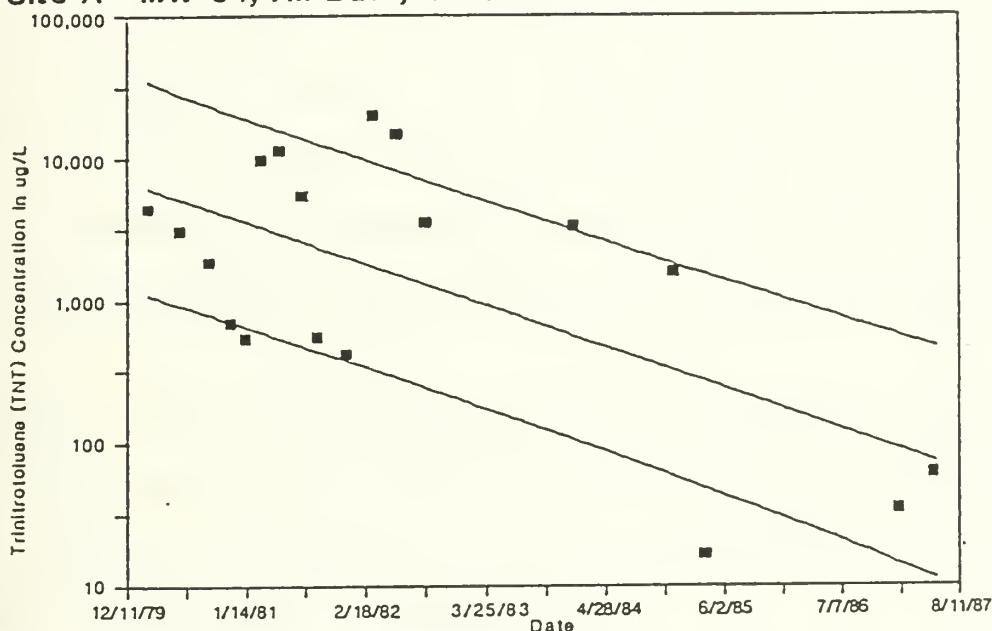
location:	SW-01	SW-02	SW-03	SW-13	SW-14
Zinc	0.008	0.1	0.005	0	0
Di-n-butyl phthalate	0	0	0	0	0
Bis(2-eh)phthalate	0	0	0	0	0
Di-n-octyl phthalate	0	0	0	0	0
2,4,6-TNT	0.01	0	0	0	0
2,4-DNT	0	0	0	0	0
2,6-DNT	0	0	0	0	0
1,3,5-TNB	0	0	0	0	0
RDX	0.001	0.002	0	0	0

The data provided in this table was taken from samples analyzed in January, 1989. However, it should be noted that samples have been collected and analyzed consistently since 1980. While most contaminant levels have remained constant or decreased slightly, there has been a considerable drop in the concentrations of TNT. Figure 11 shows the decrease in the TNT levels. Although the data is somewhat limited, particularly



after 1984, there is a definite downward trend. This decrease seems to be the result of TNT partitioning onto soil particles at the site, which would also account for the consistent high levels of TNT in surface soil samples, shown earlier.

*Site A - MW-04, All Data,  $\pm$  1 Std. Dev.*



**FIGURE 11** Graph of change in TNT concentration in groundwater [2]

The second part of the table shows values from samples taken in the areas surrounding the site. Referring back to figure 10, SW-01 through SW-03 are located to the north of the site (SW-01 is located at the exit from the surface water diversion facility), and SW-13 and SW-14 are located in the Cattail Lake drainage area. As shown, all contaminants that were detected were found at relatively low concentrations. In addition, pollutants were detected only in SW-01, SW-02, and SW-03. This shows that contamination in surface water tends to migrate north and not toward Cattail Lake. Also, since more contaminants were



found in SW-01 than any other sampling location, it appears that the surface water diversion structure has been successful in diverting surface runoff away from Cattail Lake.

Table 8 shows the contaminant concentrations found in groundwater at Site A and the surrounding area. In all cases, the only contaminant detected was RDX, which was found at relatively low levels. In most cases, the concentration did not exceed 0.002 mg/l. However, the level detected at MW-37 was 0.065 mg/l, over 30 times higher than any other sample. Looking at the location of this monitoring well, this is not surprising, since MW-37 is located directly on one of the burn mounds at the site.

Because RDX was detected in all monitoring wells adjacent to Site A, the direction of migration of the contaminants is not clear. However, the concentrations of RDX decrease as the distance from the site increases.

Groundwater samples were also collected from 8 domestic wells located outside SUBASE Bangor in the Vinland Community. However, no contaminants were detected in any of these locations [2].





TABLE 8

GROUND WATER CONCENTRATIONS AT SITE A AND VICINITY [7]  
(All concentrations are in mg/l)

## Samples at Site A:

location:	MW-12	MW-16	MW-21	MW-37
depth:	(85 ft)	(110 ft)	(91 ft)	(78 ft)
Zinc	0	0	0	0
Di-n-butyl phthalate	0	0	0	0
Bis(2-eh)phthalate	0	0	0	0
Di-n-octyl phthalate	0	0	0	0
2,4,6-TNT	0	0	0	0
2,4-DNT	0	0	0	0
2,6-DNT	0	0	0	0
1,3,5-TNB	0	0	0	0
RDX	0.002	0.0006	0.0004	0.065

## Samples adjacent to Site A:

location:	MW-28	MW-30	MW-35
depth:	(88 ft)	(100 ft)	(90 ft)
Zinc	0	0	0
Di-n-butyl phthalate	0	0	0
Bis(2-eh)phthalate	0	0	0
Di-n-octyl phthalate	0	0	0
2,4,6-TNT	0	0	0
2,4-DNT	0	0	0
2,6-DNT	0	0	0
1,3,5-TNB	0	0	0
RDX	0.0002	0.005	0.001

Bioaccumulation

The final media to be discussed is the possible bioaccumulation of contaminants in aquatic life and plant tissue. Aquatic life will be addressed first. Trout from Cattail Lake and clams and oysters from the Hood Canal were analyzed. The only contaminant found in any sample was zinc. The



concentrations in Cattail Lake trout ranged from 9 mg/kg to 26 mg/kg. The concentrations in shellfish ranged from 9 mg/kg to 220 mg/kg, with the highest concentrations detected in samples taken closest to the stormwater discharge area. No ordnance contaminants were detected [2,7].

Plant tissues concentrations, from samples collected at various locations at the site, are shown in table 9. Samples were taken from quack grass and common velvet grass found at the site. The contaminants with the highest concentrations detected were zinc and bis(2-ethylhexyl)phthalate. There were also small amounts of TNT and RDX found in some samples. This is not surprising since accumulation in plants is known for both compounds [7].

TABLE 9

PLANT TISSUE CONCENTRATIONS AT SITE A [7]  
(All concentrations are in mg/kg)

Sample number:	PT-1	PT-2	PT-3	PT-4	PT-5	PT-6	PT-7	PT-8	PT-9
Zinc	6	6	9	5	7	5	5	7	6
Di-n-butyl phthalate	0.53	0.5	0.7	0.67	0.67	1.1	0.66	1.3	0.98
Bis(2-eh)phthalate	16	2.9	0	0	0	15	18	0	7.7
Di-n-octyl phthalate	0	0	0	0	0	0	0	0	0
2,4,6-TNT	0	0	0	0	0.11	0.14	0.11	0.053	
2,4-DNT	0	0	0	0	0	0	0	0	0
2,6-DNT	0	0	0	0	0	0	0	0	0
1,3,5-TNB	0	0.035	0	0	0	0	0	0	0
RDX	0	0	0.2	0	0	0.034	0	0	0

#### SURFACE WATER CHARACTERISTICS

In this section, the surface water features of Site A and the surrounding area will be discussed, including surface runoff

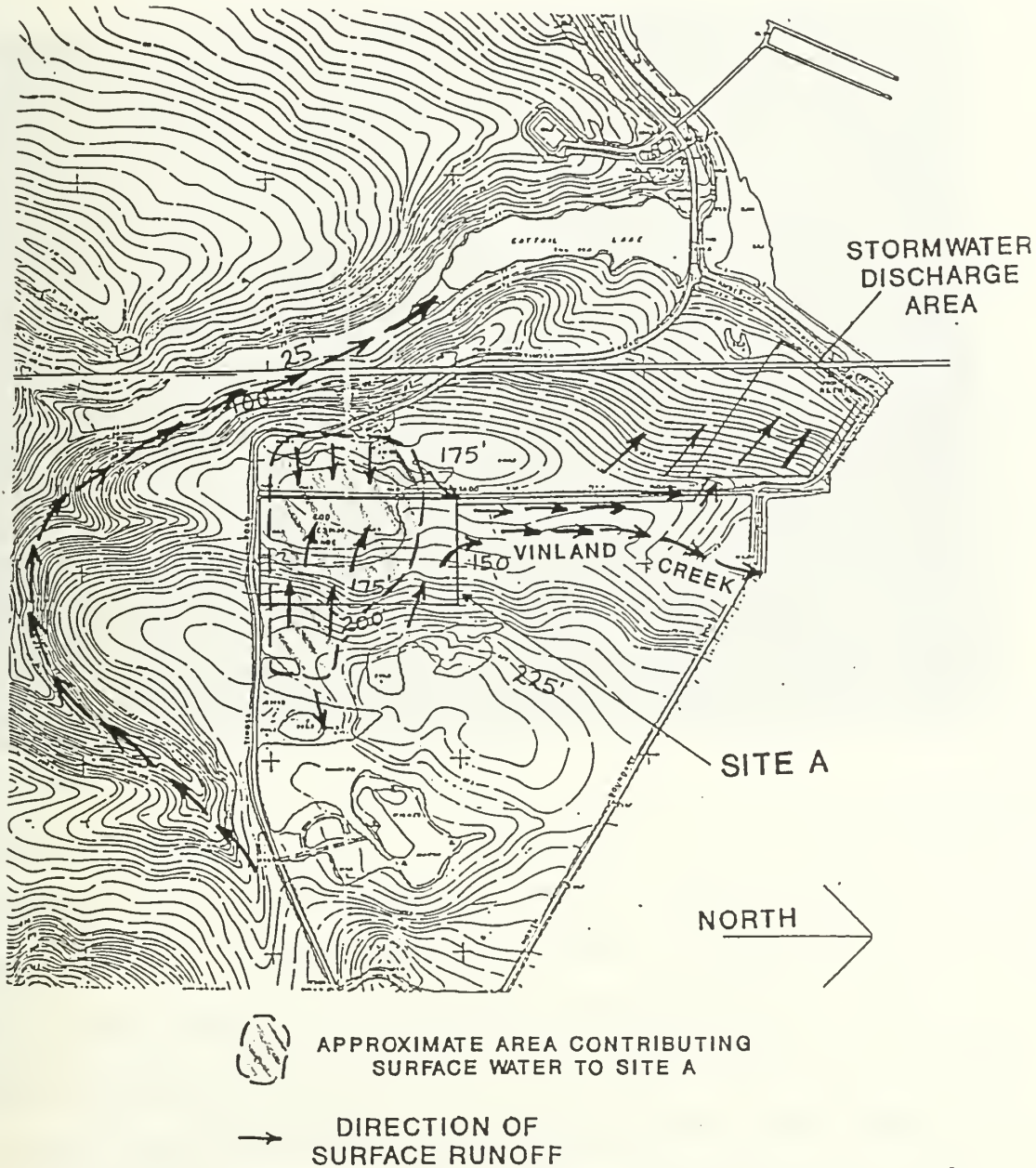


and recharge to groundwater aquifers. To get a picture of surface water flow around the site, a water balance is necessary to determine the possible impacts on surface and groundwater. According to the National Oceanic and Atmospheric Administration (NOAA), the precipitation contributing to Site A is approximately 47 inches per year, or an annual total of 24.7 million gallons for the site. Of this total, almost half, or 10.1 million gallons is lost to evapotranspiration, the combined term for evaporation and transpiration. Transpiration, in itself, is difficult to measure as it is a function of the number and types of plants, soil type, season, and temperature [9]. The remaining amount, 6 million gallons to groundwater recharge and 8.6 million gallons to surface runoff, is interesting because, as shown in earlier sections, these are possible routes of contaminant migration.

The area contributing surface runoff to Site A is roughly 19 acres in size and is shown in figure 12. After this water reaches the site it flows to one of three areas, also shown in the figure. The first is Cattail Lake drainage, a small stream to the southwest of Site A. This area of surface runoff is important because this stream flows directly into Cattail Lake, and could therefore be a pathway for contamination. Surface runoff cannot reach Cattail Lake (shown in figure 13) directly because the area between Site A and the lake is at a higher elevation than the site. In addition, the soil between Site A and Cattail Lake is not as permeable as the soil to the north of



Site A. Therefore, any surface water contributing to groundwater recharge is more likely to percolate toward the Hood Canal, rather than the lake [2].



**FIGURE 12** Map of surface water drainage at Site A [2].







The second surface discharge area is Vinland Creek, located directly north of Site A. This creek leaves SUBASE Bangor, flows through the Vinland community, and discharges directly to the Hood Canal, and therefore could contribute to the migration of contaminants to the Hood Canal.

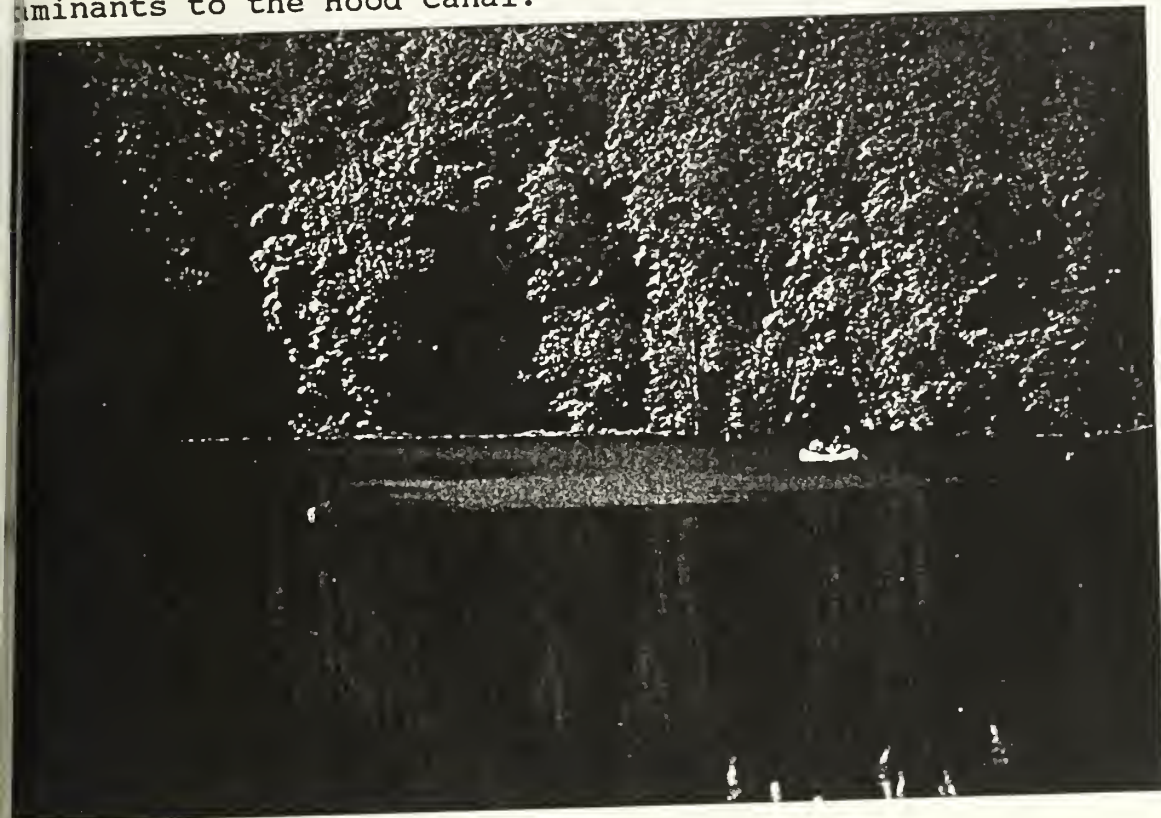


FIGURE 13 Photograph of Cattail Lake.

The final area of surface runoff is the stormwater discharge area, located to the north and west of the site. A storm water diversion facility was constructed in 1983 to direct water through a drain pipe to a stormwater discharge area. The stormwater percolates through 700 to 800 feet of semi-permeable soil in this discharge area before entering the Hood Canal, so some filtration is possible [2,7]. Figure 14 shows the inlet to the diversion structure. Figure 15 shows the route of the



structure along Pintado Road, and figure 16 shows where the water exits the structure. Finally, figure 17 shows the area between the discharge area and Hood Canal.



FIGURE 14 Photograph of inlet to surface water diversion facility





FIGURE 15 Photograph of surface water diversion facility.



FIGURE 16 Photo of exit from surface water diversion facility.







FIGURE 17 Photograph of Hood Canal.

#### HYDROGEOLOGIC CHARACTERISTICS

There are five geological zones influenced by Site A. Beginning at the surface and descending, they are the Vashon Recession Outwash (Qvr), the Vashon Till Zone (Qvt), the Vashon Advance Outwash (Qva), the Kitsap-Formation upper Lacustrine Silt Zone (Qk), and the Older Sand and Gravel Zone (Qos).

To get a better idea of where these zones are located, figures 18 and 19 show a cross sectional view of these layers. Figure 18 shows the cross section from Site A to Cattail Lake. Similarly, figure 19 shows the area from the site to the Hood Canal. Please note that in the figures, the Shallow Aquifer is located in the Qva zone. Similarly, the Sea Level Aquifer is located in the Qos zone. Both figures show the location of existing wells penetrating the various aquifers. Most wells,



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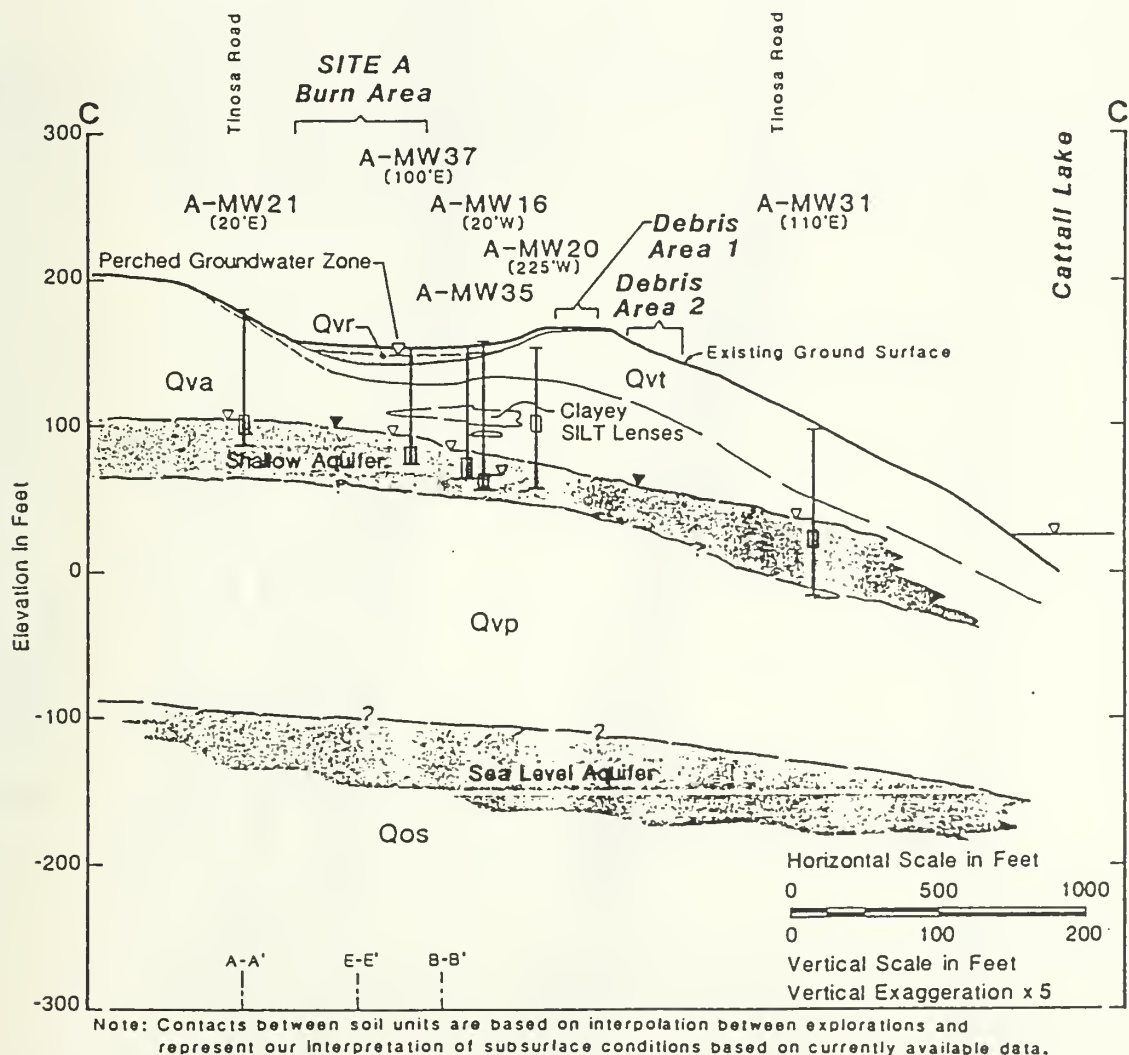
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marked MW\*\*, are for monitoring purposes only, and are not used for withdrawal. A photograph of one such well is provided in figure 20. It is also important to note that the boundaries between geologic layers are questionable. Most of these boundaries are based on interpolation between known data points [2]. This is a significant point to remember when examining the potential for migration of the contaminants found at Site A, and will be discussed in later sections of this paper.



**FIGURE 18** Cross-section of Site A to Cattail Lake [2].









FIGURE 20 Photograph of a typical monitoring well at Site A.

The physical characteristics of each hydrogeologic unit are provided in table 10, for easy comparison of each layer. Now each will be discussed separately, beginning at the surface and descending respectively.



*[The following text is extremely faint and illegible due to the quality of the scan. It appears to be a list or a series of entries, possibly a table of contents or a list of references, but the specific content cannot be discerned.]*

TABLE 10  
SUMMARY OF HYDROGEOLOGIC ZONE CHARACTERISTICS [2,7]

ZONE	SYMBOL	DEPTH (ft)	THICKNESS (ft)	HYDROL. COND (ft/day)	RE/DISCHARGE	AQUIFER?	SOIL TYPE	POROSITY
Vashon Recession Outwash	Qvr	0	10-20	0.28-1	By precip. and surface runoff	Yes (6W Zone)	Slightly Sil Gravelly SAND	0.2
Vashon Till Zone	Qvt	0-20	10-30	0.003	?	No	Very dense, Very silty SAND	?
Vashon Advance Outwash	Qva	25-45	50-135	0.14-1.4	By Qvr and local water- shed To Cattail Lk and Hood Canal	Yes (Shallow Aquifer)	Medium to fi sand, very sandy SILT	0.25
Kitsap Formation Upper Lacustrine Silt	QK	50-100	140-350	?	?	No	Clayish sandy SILT	?
Older Sand Gravel	Qos	250-350	200	50-100	To Hood Canal	Yes (Sea Level Aquifer)	Sand and Gravel	?

The first zone to be discussed is the Vashon Recession Outwash (Qvr). This unit has scattered deposits of unconsolidated sand and gravel, and some thinner silt layers directly on top of the underlying zone. As a result, it does have the ability to hold groundwater, and is referred to as the Perched Groundwater Zone [7]. This layer is a seasonal unit, because its thickness increases during the wet winter months and decreases during the summer months. During very dry periods it can completely dry up in the area directly under Site A. Because this layer is limited in size and somewhat seasonal, there are no withdrawal wells tapped into this zone [2].







Since it is on the surface, this layer is recharged by precipitation and surface runoff. The flow in this layer is toward the northwest, to the stormwater discharge area and Hood Canal. The transmissivity through this zone is low, at only 0.01. This zone consists of glacial till, with a porosity of roughly 0.2 [2].

The second hydrogeological unit, lying just under the Qvr zone and extending to a depth of roughly 20 feet, is the Vashon Till Zone (Qvt) which is a very dense, poorly mixed layer of sand, silt, and gravel. Because this layer is not homogeneous, permeability is low, particularly in areas with more silt. It generally acts as an aquitard, but does contain small pockets of groundwater in areas where its constituents are better mixed. In the area of Site A, it is more consistently mixed than in other areas, and does have pockets of water during the wet season.

The depth of the Vashon Till zone (Qvt) varies, depending on its location (i.e. it is exposed to the surface in some areas). In addition, this zone has a much larger surface area than the overlying layer [2].

The third hydrogeologic zone is the Vashon Advance Outwash (Qva). This layer consists of well-stratified gray to brown sand with scattered pockets of silt and gravel. It is a partially confined water bearing zone, containing the Shallow Aquifer. This zone supplies several private wells in the Vinland community, thus contamination is of great concern. The Vashon Advance



Outwash appears to have a large surface area.

Recharge to this layer is from percolation from the Perched Groundwater Zone and from local watershed to the aquifer. The hydraulic conductivity varies from 0.14 to 1.4 feet per day [2]. Discharge flows to Cattail Lake Drainage and the Hood Canal [7].

The Kitsap Formation-Upper Lacustrine Silt Zone (Qk) consists of hard, gray sand laminated to massive silt, and is characterized by fine material and low hydraulic conductivity. It is relatively impermeable and acts as an aquitard between the Shallow Aquifer and the underlying layer. A few intermediate groundwater aquifers do exist within this zone, but are restricted from recharge and discharge. Regarding size, the Qk zone is larger than any overlying units [2,7].

The final hydrogeologic zone to be addressed is the Older Sand and Gravel Zone (Qos), which consists generally of sand and gravel, with smaller amounts of silt and till in some areas. It contains the Sea Level Aquifer, which is the supply zone for Public Utility District No. 1 (containing two well systems).

Located at a depth of between 100 and 200 feet below sea level (or 250 to 350 feet from the surface), discharge from this aquifer flows to the Hood Canal.

#### SUMMARY OF SITE A CHARACTERISTICS AND IMPACTS

##### Human exposure

A major concern for any hazardous waste site is the potential for human exposure and the possible effects. Now that Site A has been characterized, this aspect of an RI will be



addressed. Possible pathways for human exposure from Site A are listed below and the potential of exposure for each of them is discussed:

1. Drinking water - This is the primary pathway for ordnance compounds to reach humans, which could be significant since there are elevated levels of some contaminants in groundwater. This is why the rate and direction of migration in groundwater must be carefully studied.

2. Consumption of shellfish - Elevated concentrations of some ordnance compounds and metals were detected in shellfish samples. However, there is not enough data to make any quantified conclusions about this pathway. As a conservative measure, the beaches around discharge points from Site A have been closed to shellfishing.

3. Dermal contact - An important pathway, which would occur if soil from the site got onto exposed skin. As a result, Site A has been fenced in to prevent unauthorized entry, and there are strict clothing and safety restrictions for those who are permitted access. Revegetation at the site has also reduced the chance for dermal contact with contaminated soil.

4. Inhalation of compounds - This is similar to dermal contact in that contaminated soil particles would be inhaled through the lungs. Again, the restricted access has reduced the possibility of this happening.

#### Site A summary

The sampling conducted at Site A shows that contamination



has migrated through soil, surface water, and groundwater. The highest levels of contamination are limited to the soil media, in particular, surface soils directly on the site. However, there are elevated contaminant levels (zinc, TNT, 2,4 DNT, and RDX) in soil samples adjacent to the site, showing a migration pattern toward the Cattail Lake drainage ravine. Because of the low  $K_d$  partitioning values of these compounds, high soil concentrations are expected.

Contamination in surface water is different from that of soil. Both TNT and zinc were detected in surface samples but at relatively low concentrations. Based on sampling data, contaminant migration in surface water is moving toward the stormwater discharge area, showing the success of the stormwater diversion structure in directing the flow of surface runoff.

The only contaminant detected in groundwater was RDX, found in samples both on and adjacent to Site A. However, concentrations were low, possibly due to this compound's low solubility and high affinity for sorbing onto solids.

Contaminant in sediment and plant tissues is limited to zinc. But there were also elevated concentrations of phthalates in plant tissue.

Based on the sampling conducted at Site A and vicinity, the majority of the contamination is limited to the soil media, with small levels occurring in surface and groundwater. Although some conclusions about contaminant migration can be made with the available data, they are only quantitative (i.e. direction of







flow only, no flow rates). The fact that migration cannot be quantified with the existing data is one of the limitations of the sampling done at this site.

### COMPUTER MODELING

#### Why use models?

For years computer models have been used to simulate situations in the real world. One of the benefits of modeling is that they provide a simple and economically feasible way to look at various scenarios without extensive field work. The idea of modeling can also be applied to hazardous waste sites. While field sampling is still required to obtain the amount and concentrations of contaminants at a site, it is often difficult to determine the migration patterns and flow rates of contaminants from that site. Computer modeling of hazardous waste sites can help in determining the migration potential of contaminants, specifically in groundwater.

Chu et al. (1987) examined the data requirements for groundwater modeling. In this study, they were given a limited amount of data for a hypothetical aquifer. Their objective was to "evaluate the effects of data availability and uncertainty on parameter estimation for groundwater contaminant transport." In other words, they wanted to see how closely the model could simulate contaminant migration in the test aquifer. The computer model used in this study was the U.S. Geological Survey's Method of Characteristics (USGS-MOC) [1]. This widely-used model is so named because it uses the method of characteristics to solve the



solute transport equation in the model, a method developed to solve hyperbolic differential equations.

The results showed that the ability of USGS-MOC (and therefore similar computer models) to predict contaminant migration is limited by the extent and the quality of the data provided for the aquifer. According to Chu,

"The predictive ability of such numerical models is limited by the assumptions and approximations introduced in the governing equations and their solutions, the model parameter values used, the availability and quality of the data for model calibration, and the characteristics of the physical system." [1]

Since modeling appears to be restricted by data requirements, why use them? Again referring to Chu, while simulation models may be limited by data requirements, they do "offer a valuable tool for groundwater contamination assessments." [1] The bottom line is that as long as model results are accompanied by some uncertainty analysis, they provide a method to predict the migration patterns of contaminants from hazardous waste sites.

#### Why model the site?

There are three significant advantages to applying USGS-MOC to Site A. First, after reviewing the existing information for the site, it is clear that while extensive sampling was done, there are still questions regarding contaminant migration,



particularly in groundwater. These questions must be answered before an accurate evaluation can be made. Secondly, using the model is an easy way to vary unknown parameters and look at the effects on contaminant migration. It should be noted that modeling different scenarios will not provide a complete, accurate picture of the site. But by changing the parameters where data is limited and examining the effects, I can determine which factor (i.e. aquifer thickness, transmissivity, etc) has the largest control over migration patterns. This leads to the third advantage. Finding the factor with the most control on migration will show where efforts should be concentrated in further field study or development of remediation alternatives.

To model Site A, USGS-MOC will be applied to the shallow aquifer under the site. Because the perched groundwater zone is seasonal and directly on the surface, it is easily accessible for sampling and will not be used in the modeling exercise. The sea level aquifer will also not be used as it is not effected by the contamination at the site. On the other hand, the shallow aquifer is subject to contamination, and does supply water to several domestic wells in the Vinland area.

The model results will not provide a complete and accurate evaluation of Site A. However, it will be a good demonstration of this groundwater model, and meet my objective of gaining experience with computer models.

#### USGS-MOC

USGS-MOC, used in Chu (et al.)'s study, is a popular



groundwater model used for predicting contaminant migration. In order to examine the set-up of this model, the basics of groundwater flow, as seen in USGS-MOC, should be addressed. Groundwater flow in an aquifer is a combination of four processes, which are listed below:

1. Convective transport.
2. Hydrodynamic dispersion.
3. Combination of fluid sources - when water of one composition comes in contact with water of another composition.
4. Reactions - chemical reactions of the solute and surrounding substances, including sorption onto solids, ion exchange, biological reactions, etc.

In USGS-MOC, the groundwater flow equation is coupled with a solute-transport equation to analyze flow in a simulated aquifer. However, there are limitations to using this model. First, USGS-MOC is applicable to one and two dimensional flow problems, only. Second, it is limited to either transient flow or steady state flow. The third limitation is that the model assumes that the solute in question is non-reactive and that fluid density, viscosity, and temperature do not affect the velocity distribution. Lastly, the boundary conditions of the aquifer to be modeled must be chosen carefully.

When establishing specific boundary conditions, they may be either constant-head boundaries or constant-flux boundaries. A constant-head boundary is a location where the head does not





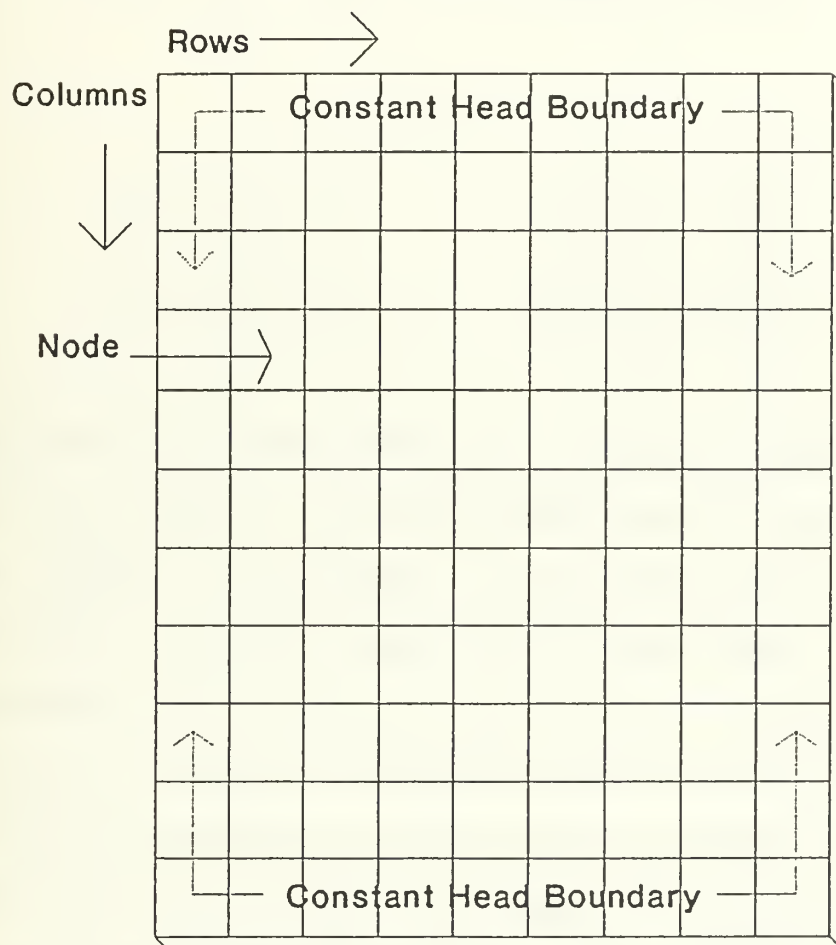


change with time. It may be the true aquifer boundary, or an artificial boundary set for modeling purposes only. A constant-flux boundary can represent aquifer underflow, or well injection or withdrawal. Modes of aquifer recharge or discharge (i.e. by percolation from rainfall, etc) are ignored in the model. Once these boundaries are set, the area within them represents the aquifer. This area is called a finite-difference grid, so named because "a finite-difference equation describing the effects of hydrodynamic dispersion, fluid sources and sinks, and divergence of velocity" [6] is used in the model. The grid consists of a set of rows and columns of nodes, with each node representing a certain area of the aquifer. The outer rows and columns of the grid represent no-flow boundaries (i.e. the constant-head or constant-flux conditions in the aquifer). Since calculations are made at each node for every time increment in the model run, the grid is limited to no more than 20 rows and columns, or 400 nodes. In addition, since the outer nodes are considered the no-flow areas, the aquifer, itself, is limited to 18 rows and columns, or 324 nodes [6]. An example of this grid is shown in figure 21.



# USGS-MOC

## Finite-Difference Grid

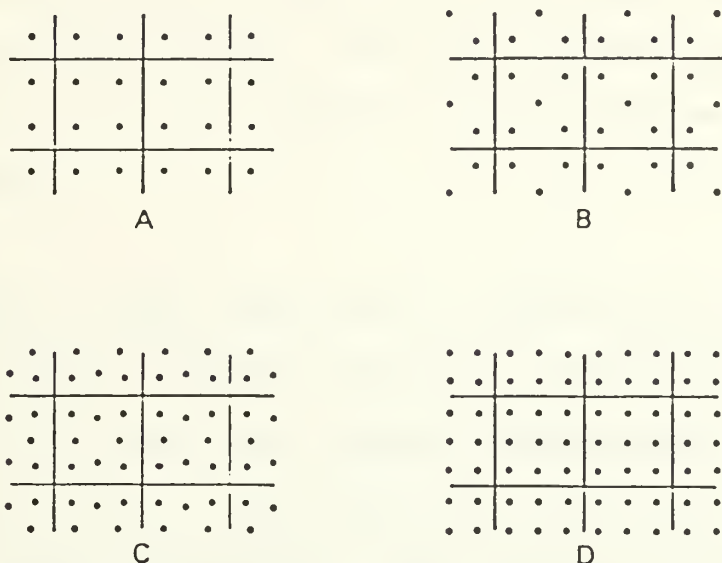


**FIGURE 21** Finite-difference grid for computer model USGS-MOC [6].

This model allows for four, five, eight, or nine tracer particles to be used per node. These particles are used to calculate the concentration of contaminant in each node at each chosen time increment. Initial particle distributions are shown



in figure 22. The best results, with the least amount of error in the chemical mass balance, are obtained if nine particles per node are used [6].



**FIGURE 22** Particle distribution for finite-difference grid [6].

One other source for mass balance error is the node or cell distance (CELDIS in the model), or the distance the solute travels within each node over one time increment. Verification test runs show that the least error and best results occur when CELDIS is set to 0.5, or half the distance of one node. However, there is little variation between setting CELDIS equal to 0.5 or 1. The bottom line is that the distance of solute transport during one time increment should be at least half the node distance, and no lower [6].

Any number of injection or withdrawal wells can be used in USGS-MOC. However, only one well may be placed per node. If more than one well exists within one node, the average rate of recharge or withdrawal must be used for all wells in that region.



The number of observation points, or monitoring wells, is limited to five [6]. These are used to examine the variation in concentration at any one point over the entire time period specified for the program. They may be placed anywhere within the grid area, with the exception of the no-flow regions.

#### MODELING SITE A

##### Input data

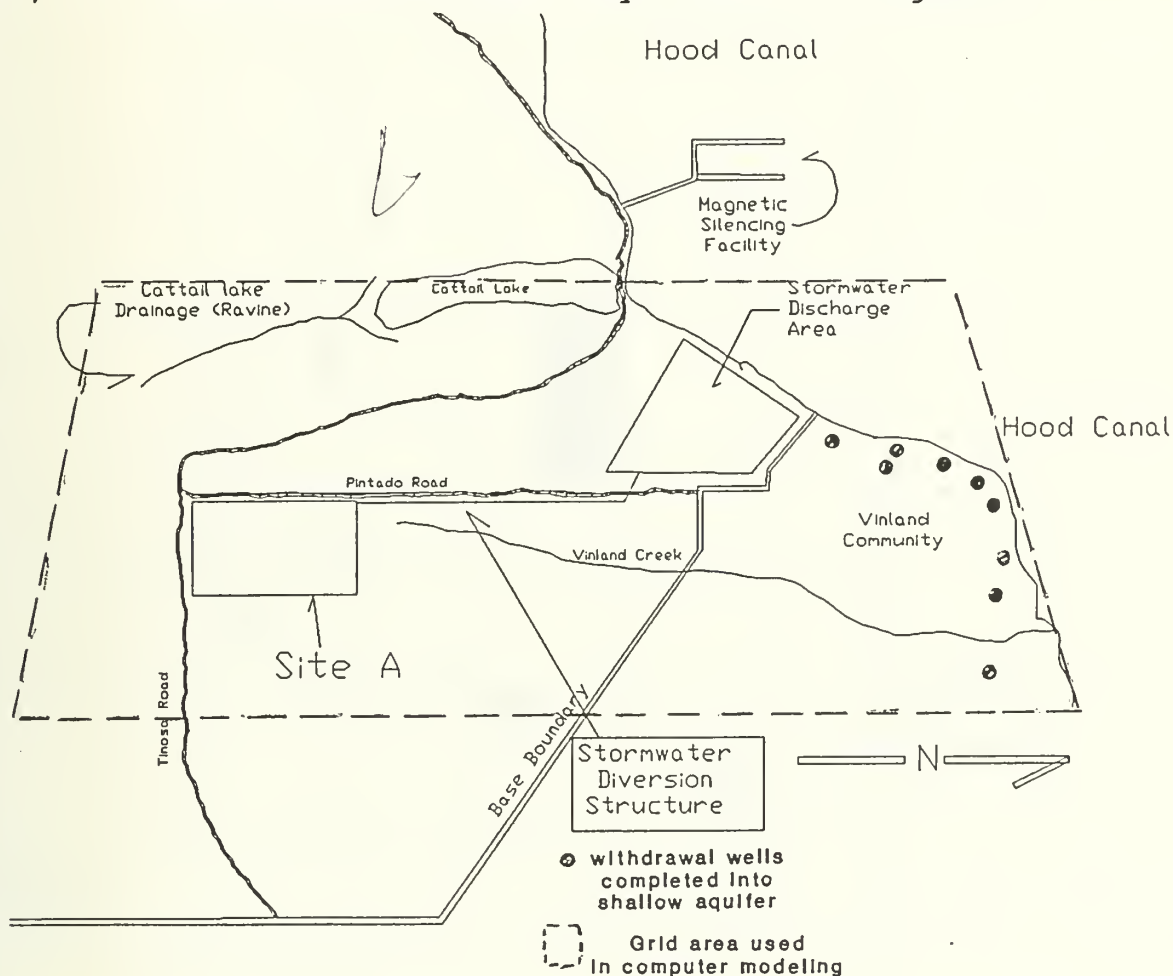
In order to apply the model to the shallow aquifer, the input data should represent the actual site as closely as possible. To do this, the finite-difference grid was set up to simulate the area in figure 23. This map shows Site A, the Hood Canal, and the Vinland wells. An outline of the proposed grid is also shown in this figure. It can be compared to figure 24, which is the model representation of the same area. On the grid, Site A is in the same location, relative to the Vinland wells and the Hood Canal. Because of the limited grid area, only five withdrawal wells are used. The Hood Canal is represented by the constant-head boundaries on the northern and western edges of the grid. The southern and eastern edges are artificial boundaries used for modeling purposes. In addition, there are four observation points on the grid. These will be used to compare the results of the various test runs of the model.

Table 11 shows the known input parameters used when modeling Site A. These values were chosen because they provide a somewhat accurate simulation of the site. The pumping rates for the withdrawal wells in Vinland are estimates based on personal





interviews with owners of private wells and water consumption data from Public Utilities District #1 (PUD 1). Note that two pumping rates are shown. One represents withdrawal for household use, and the other is the rate required for irrigation.



**FIGURE 23** Map of Site A in relation to Hood Canal and Vinland area wells [2].



# MODELING SITE A

## Program - USGS MOC

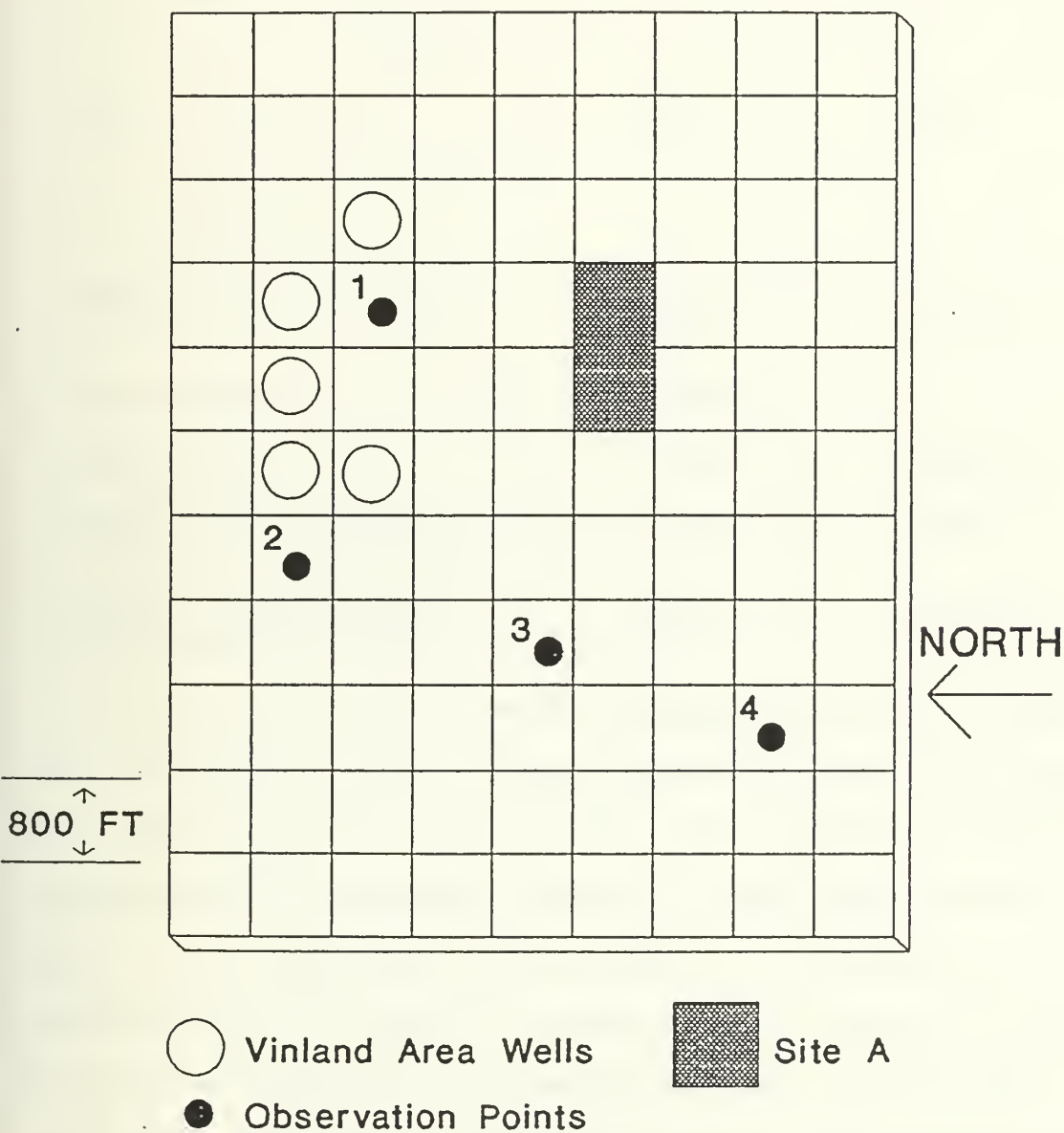


FIGURE 24 Finite-difference grid applied to Site A.



TABLE 11

KNOWN INPUT PARAMETERS FOR MODELING SITE A [2,6].

<u>Parameter</u>	<u>Setting</u>	<u>Units (If Applicable)</u>
# of cells, X direction	9	
# of cells, Y direction	11	
Width of each cell	800.0	feet
# of observation points	4	
# of withdrawal wells	5	
Pumping rate for wells	0.01 10.0	cf/sec
Soil porosity	0.25	
Selected run time	5.0	years
Initial concentration of contaminant in aquifer	0.0	mg/L
Initial concentration of contaminant at source	100.0	mg/L

Since my objective was to compare results for various test runs, and not to obtain actual migration rates, the time selected for running the model was 5 years. The initial concentration of contaminant at the source (Site A in this case) was set at 100 mg/L. This figure was chosen because it relates to the solubility of 2,4,6-TNT, a contaminant of concern in groundwater. Although well above the concentrations of contaminants detected at Site A, this initial concentration was chosen so the results would emphasize the potential for migration from the site to surrounding areas.

There are four aquifer characteristics which are unknown or



roughly estimated based on limited data. They are dispersion ratio, aquifer thickness, water table height, and transmissivity. During the model runs, these parameters were changed one at a time in order to examine the effects of each on migration, resulting in a total of five test runs of USGS-MOC. Table 12 shows the values chosen for each test run. The varied parameter values in runs 2 through 5 were chosen based on a range of estimates listed in the Current Situation Report. For example, the aquifer thickness is known to be between 25 and 45 feet, so the standard run uses 25 feet and the variation uses 45 feet.

To run the model, data is placed in an input file. A sample input file, with explanations for each term, is in appendix 2. The input file is made up of three data cards (named from a time when computers required cardboard cards for input, the name was never updated) and nine data sets. Files may be changed and saved with most word processing programs.





TABLE 12  
MODELING SITE A, TEST RUN DATA

Test No. 1: Standard Run

Withdrawal Wells	5
Dispersion Ratio	0.3
Transmissivity	0.14
Aquifer Thickness	25
Water Table height	50

Test No. 2: Dispersion Ratio

Withdrawal Wells	5
Dispersion Ratio	0.9
Transmissivity	0.14
Aquifer Thickness	25
Water Table height	50

Test No. 3: Aquifer Thickness

Withdrawal Wells	5
Dispersion Ratio	0.3
Transmissivity	0.14
Aquifer Thickness	45
Water Table height	50

Test No. 4: Water Table

Withdrawal Wells	5
Dispersion Ratio	0.3
Transmissivity	0.14
Aquifer Thickness	25
Water Table height	135

Test No. 5: Transmissivity

Withdrawal Wells	5
Dispersion Ratio	0.3
Transmissivity	0.04
Aquifer Thickness	25
Water Table height	50

Results of modeling

When a test run is completed, the results are placed into an output file. Because of the number of time increments required for each run, these files are quite lengthy. Unfortunately, in



USGS-MOC, the time increments for calculations cannot be changed. However, the output file can be edited in a word processing program after the run is completed. A complete sample output file for test run number one (standard) is in appendix 3. Output files include grids showing the concentration and changes in concentration for each time increment. The model also calculates the chemical mass balance for each time increment and places it in the output file, as well. In addition, the concentration and head at each selected observation point is shown for each time increment.

As stated in the introduction, one of the main objectives of this paper is to examine and compare the specific results for the five test runs involving Site A. Therefore, they will be addressed in detail in the discussion section.

## DISCUSSION

### Test run results, Site A

The output files for each test run include a concentration grid for each time increment. This grid shows the shape of the plume and the contaminant concentrations at each node or cell in the grid. Remember, the objective is to vary certain aquifer parameters and look at the effects on migration. An excellent way to do this is to compare the concentration grids for each test run at the end of 1 year, 3 years, and 5 years.

In figure 25, each concentration grid is color coded, depending on the degree of contamination to facilitate comparing contamination distributions. Every 8 mg/L change in



concentration is represented by a different color.

## COLOR CHART

### For Plume Shape and Concentration

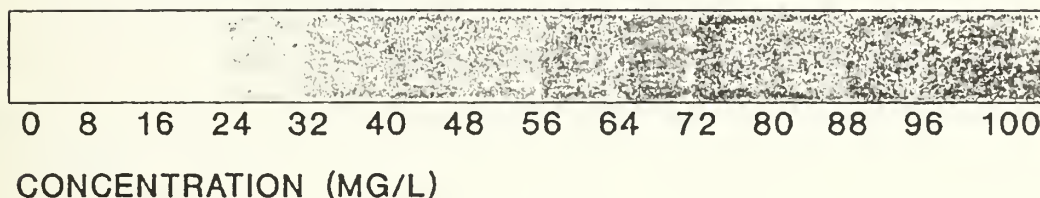


FIGURE 25 Color chart for plume shape and concentration.

Figure 26 shows the concentration grids for the "standard" test run. This will be the basis for comparison with the other model results. Figure 24 may be referred to for the location of Site A and the Vinland wells on the grid. Looking at figure 26, the highest contaminant concentration remains at Site A. The direction of flow of the plume shows the effect, or pull, of the Vinland wells. However, even with the effect of the wells, the plume is still moving down-gradient, toward the constant-head boundary representing the Hood Canal, at the bottom of the grid. Over time, the general shape of the plume does not change, but the higher concentrations in the center of the plume do spread to cover a larger area. For this run, there is only 1 withdrawal well showing any contamination.

Figure 27 shows the concentration grids after increasing the dispersion ratio from 0.3 to 0.9. Notice that there is little



difference between this grid and the standard run, in that the plume shapes are very similar. However, the contaminant concentrations in the center of the plume are lower for this run. In addition, the concentrations to the right of Site A, away from the wells, are slightly elevated. This is expected because with a higher dispersion ratio, the plume would tend to spread more while heading down-gradient. But overall, even with these small differences, it appears that dispersion ratio is not a major controlling factor on the degree of migration in this case. As with the standard run, there is only 1 withdrawal well with any contamination.





## CONCENTRATION

TIME: 1 YEAR

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	2	3	0	0	0
0	0	2	2	4	30	93	3	0	0
0	0	6	26	53	84	87	25	1	0
0	0	7	68	81	82	68	10	1	0
0	0	7	37	82	84	51	12	1	0
0	0	2	24	71	73	39	8	1	0
0	0	0	3	67	63	16	7	1	0
0	0	0	0	0	0	0	0	0	0

TIME: 3 YEARS

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	2	3	30	95	3	0	0
0	0	15	32	47	90	93	14	0	0
0	0	62	76	84	89	88	9	1	0
0	0	60	84	86	84	51	7	1	0
0	0	39	80	82	78	14	6	1	0
0	0	4	47	80	73	23	7	2	0
0	0	0	0	0	0	0	0	0	0

TIME: 5 YEARS

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	2	4	29	95	3	0	0
0	0	12	23	52	90	93	14	0	0
0	0	67	80	86	90	88	9	1	0
0	0	70	83	85	84	52	7	1	0
0	0	55	82	80	81	15	7	1	0
0	0	15	68	78	75	18	7	1	0
0	0	0	0	0	0	0	0	0	0

□ SITE A

○ WITHDRAWAL WELLS

SITE A TEST NO. 1 - 5 WITHDRAWAL WELLS, DISPERSION RATIO 0.3, TRANSMISSIVITY 0.14, AQUIFER THICKNESS 25 FEET, WATER TABLE HEIGHT 50 FEET, RUN TIME 5 YEARS.

FIGURE 26 Concentration grids for test run 1 (Standard).



## CONCENTRATION

## TIME: 1 YEAR

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	①	0	0	0	0	0	0	0
0	①	0	0	1	3	4	1	0	0
0	①	3	4	8	30	88	7	1	0
0	①	⑧	25	50	76	80	30	2	0
0	0	13	59	70	72	63	17	4	0
0	0	9	41	71	73	50	21	5	0
0	0	3	23	60	62	43	16	6	0
0	0	0	4	53	52	28	16	7	0
0	0	0	0	0	0	0	0	0	0

## TIME: 3 YEARS

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	①	0	0	0	0	0	0	0
0	①	0	0	1	3	3	1	0	0
0	①	4	4	7	31	89	7	1	0
0	①	⑤	30	46	81	85	21	2	0
0	0	54	64	72	78	76	18	4	0
0	0	51	70	72	71	49	15	5	0
0	0	35	66	70	66	25	15	6	0
0	0	4	43	65	62	32	15	7	0
0	0	0	0	0	0	0	0	0	0

## TIME: 5 YEARS

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	①	0	0	0	0	0	0	0
0	①	0	0	1	2	3	1	0	0
0	①	5	4	8	30	90	7	1	0
0	①	⑫	23	50	81	85	21	2	0
0	0	57	66	72	78	77	19	4	0
0	0	59	70	71	71	51	16	5	0
0	0	46	69	65	67	27	16	6	0
0	0	14	59	64	63	29	16	7	0
0	0	0	0	0	0	0	0	0	0

□ SITE A  
○ WITHDRAWAL WELLS

SITE A TEST NO. 2 - 5 WITHDRAWAL WELLS, DISPERSION RATIO 0.9, TRANSMISSIVITY 0.14, AQUIFER THICKNESS 25 FEET, WATER TABLE HEIGHT 50 FEET, RUN TIME 5 YEARS.

FIGURE 27 Concentration grids for test run 2 (Dispersion Ratio).



Figure 28 shows the concentration grids after increasing the aquifer thickness from 25 feet to 45 feet. Again, there are no significant differences between these grids and the standard run.

In this grid, the contaminant concentrations in the center of the plume are only slightly lower, but the shape is very close to the standard. This is not surprising, since a change in aquifer thickness would effect migration in the vertical direction more than it would effect the plume shape. Unfortunately, USGS-MOC does not have the ability to show migration in the vertical direction. In the end, it appears that aquifer thickness, like dispersion ratio, is not a controlling factor on migration.

Figure 29 shows the results of changing the water table height from 50 feet to 135 feet. Unlike prior test runs, these grids are much different than the standard run grids. The highest contaminant concentrations are no longer limited to Site A. In fact, concentrations of over 96 mg/L appear in one-third of the plume for all 3 time increments. Remember, the maximum initial concentration was only 100 mg/L. In addition, because of the large change in gradient (from 135 feet to 0 over the grid area), the Vinland wells appear to have only a minor effect on the plume shape. The concentrations on the left side of the plume (brown in color) are slightly higher than the concentrations on the right side (maroon in color), showing a slight pull toward the wells.





## CONCENTRATION

TIME: 1 YEAR

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	①	0	0	0	0	0	0	0
0	①	0	0	0	1	3	0	0	0
0	①	2	2	4	37	95	3	0	0
0	①	④	33	36	90	94	7	0	0
0	0	4	64	83	89	88	9	1	0
0	0	1	19	28	80	51	8	1	0
0	0	0	2	44	69	13	7	1	0
0	0	0	0	16	28	10	4	1	0
0	0	0	0	0	0	0	0	0	0

TIME: 3 YEARS

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	①	0	0	0	0	0	0	0
0	①	0	0	0	1	3	0	0	0
0	①	3	2	4	28	95	3	0	0
0	①	⑦	31	47	90	93	13	0	0
0	0	17	79	86	90	88	9	1	0
0	0	33	77	82	84	51	7	1	0
0	0	6	70	78	81	15	7	1	0
0	0	1	22	78	76	18	7	1	0
0	0	0	0	0	0	0	0	0	0

TIME: 5 YEARS

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	①	0	0	0	0	0	0	0
0	①	0	0	0	1	2	1	0	0
0	①	3	2	4	30	95	15	0	0
0	①	④	25	52	88	92	7	0	0
0	0	55	77	80	82	76	7	1	0
0	0	52	83	87	87	39	9	1	0
0	0	38	79	82	75	44	6	1	0
0	0	4	46	79	71	23	8	1	0
0	0	0	0	0	0	0	0	0	0

□ SITE A  
○ WITHDRAWAL WELLS

SITE A TEST NO. 3 - 5 WITHDRAWAL WELLS, DISPERSION RATIO 0.3, TRANSMISSIVITY 0.14, AQUIFER THICKNESS 45 FEET, WATER TABLE HEIGHT 50 FEET, RUN TIME 5 YEARS.

FIGURE 28 Concentration grids for test run 3 (Aquifer Thickness).





## CONCENTRATION

TIME: 1 YEAR

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	①	0	0	2	1	2	0	0
0	①	0	0	5	47	23	34	2	0
0	①	1	7	50	86	99	76	6	0
0	①	③	47	84	98	99	88	14	0
0	0	5	88	96	99	98	85	21	0
0	0	8	93	98	99	97	85	22	0
0	0	12	91	98	99	97	81	25	0
0	0	14	89	98	98	96	81	23	0
0	0	0	0	0	0	0	0	0	0

TIME: 3 YEARS

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	①	0	0	2	2	2	0	0
0	①	0	0	5	42	81	33	2	0
0	①	1	7	53	84	99	71	7	0
0	①	③	46	81	98	99	89	18	0
0	0	5	89	96	99	98	85	25	0
0	0	8	93	98	99	97	83	21	0
0	0	12	91	98	99	97	82	23	0
0	0	14	89	98	98	96	80	27	0
0	0	0	0	0	0	0	0	0	0

TIME: 5 YEARS

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	①	0	0	2	2	2	0	0
0	①	0	0	4	39	80	31	2	0
0	①	1	7	54	87	99	73	6	0
0	①	③	39	83	98	99	86	18	0
0	0	5	89	96	98	98	83	20	0
0	0	8	93	98	99	97	83	21	0
0	0	12	91	98	99	97	82	24	0
0	0	14	89	98	98	96	80	27	0
0	0	0	0	0	0	0	0	0	0



SITE A

WITHDRAWAL WELLS

SITE A TEST NO. 4 - 5 WITHDRAWAL WELLS, DISPERSION RATIO 0.3, TRANSMISSIVITY 0.14, AQUIFER THICKNESS 25 FEET, WATER TABLE HEIGHT 135 FEET, RUN TIME 5 YEARS.

FIGURE 29 Concentration grids for test run 4 (Water Table)



The overall results of this test run show that the plume is more highly concentrated and much larger than the standard. Therefore, the migration potential appears to increase noticeably with an increase in water table height or aquifer gradient.

The concentration grids for the final test run are shown in figure 30. In these grids, the transmissivity was changed from 0.14 to 0.04. Decreasing this parameter seems to have the opposite effect of increasing the gradient. Like other test runs, the highest contaminant concentration appears at the site. But in this case, the plume appears to be moving in two different directions. On the left side, the effect of the Vinland wells is obvious. In fact, the pull of the wells seems to be the strongest influence on the plume shape. This is expected with such a low transmissivity. However, on the right side of the plume, away from the wells, the gradient has the strongest influence on contaminant migration. Although the concentrations are low, averaging 4 mg/L, the plume is still moving down-gradient, toward the Hood Canal.

As a final note for this run, although the dispersion ratio is unchanged, the plume is more wide-spread than the standard run, particularly up-gradient of the site. Reasons for this are unknown. Perhaps it is the result of a slow migration rate, in that with slower migration, the contaminant may have a better chance of dispersing in more directions, than with a higher flow rate.



## CONCENTRATION

TIME: 1 YEAR

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	①	0	0	2	2	1	0	0
0	①	1	1	10	51	66	13	0	0
0	①	7	21	60	84	92	41	2	0
0	①	②	42	89	93	93	38	3	0
0	0	0	6	48	67	62	7	3	0
0	0	0	0	2	5	7	3	2	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

TIME: 3 YEARS

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	①	0	0	2	3	1	0	0
0	①	1	0	10	51	73	11	0	0
0	①	7	22	66	85	98	40	2	0
0	①	①	44	87	95	94	40	3	0
0	0	0	8	41	59	58	10	4	0
0	0	0	0	4	10	8	5	4	0
0	0	0	0	0	0	0	3	3	0
0	0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	0	0	0

TIME: 5 YEARS

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	①	0	0	2	3	1	0	0
0	①	0	0	13	45	70	16	0	0
0	①	7	21	61	86	97	39	2	0
0	①	②	50	87	94	93	37	3	0
0	0	0	6	41	60	52	10	4	0
0	0	0	1	2	9	8	5	4	0
0	0	0	0	0	1	0	3	3	0
0	0	0	0	0	0	0	3	1	0
0	0	0	0	0	0	0	0	0	0

□ SITE A

○ WITHDRAWAL WELLS

SITE A TEST NO. 5 - 5 WITHDRAWAL WELLS, DISPERSION RATIO 0.3, TRANSMISSIVITY 0.04, AQUIFER THICKNESS 25 FEET, WATER TABLE HEIGHT 50 FEET, RUN TIME 5 YEARS.

FIGURE 30 Concentration Grids for test run 5 (Transmissivity).





### Results of selected observation points, Site A

After comparing all test runs, it is clear that water table height and transmissivity effect the migration of contaminants at Site A more than other parameters. However, before any specific conclusions are drawn, one more set of comparisons should be made. The model results for all runs should be compared at selected observation points. Please refer back to figure 24 for the specific location of the four observation points selected for these model runs.

Observation point one is located to the north of Site A, next to the Vinland area withdrawal wells. This location was chosen to look at the effects of the wells on migration, without the effects of a constant-head boundary. Figure 31 is a graph showing the change in concentrations at observation point one over the selected run time. The graph covers the five year period, because it is important to see not only the final concentration for each test run, but also the trend over the entire time.





# MODELING SITE A

## Comparing Results at Observation Point 1

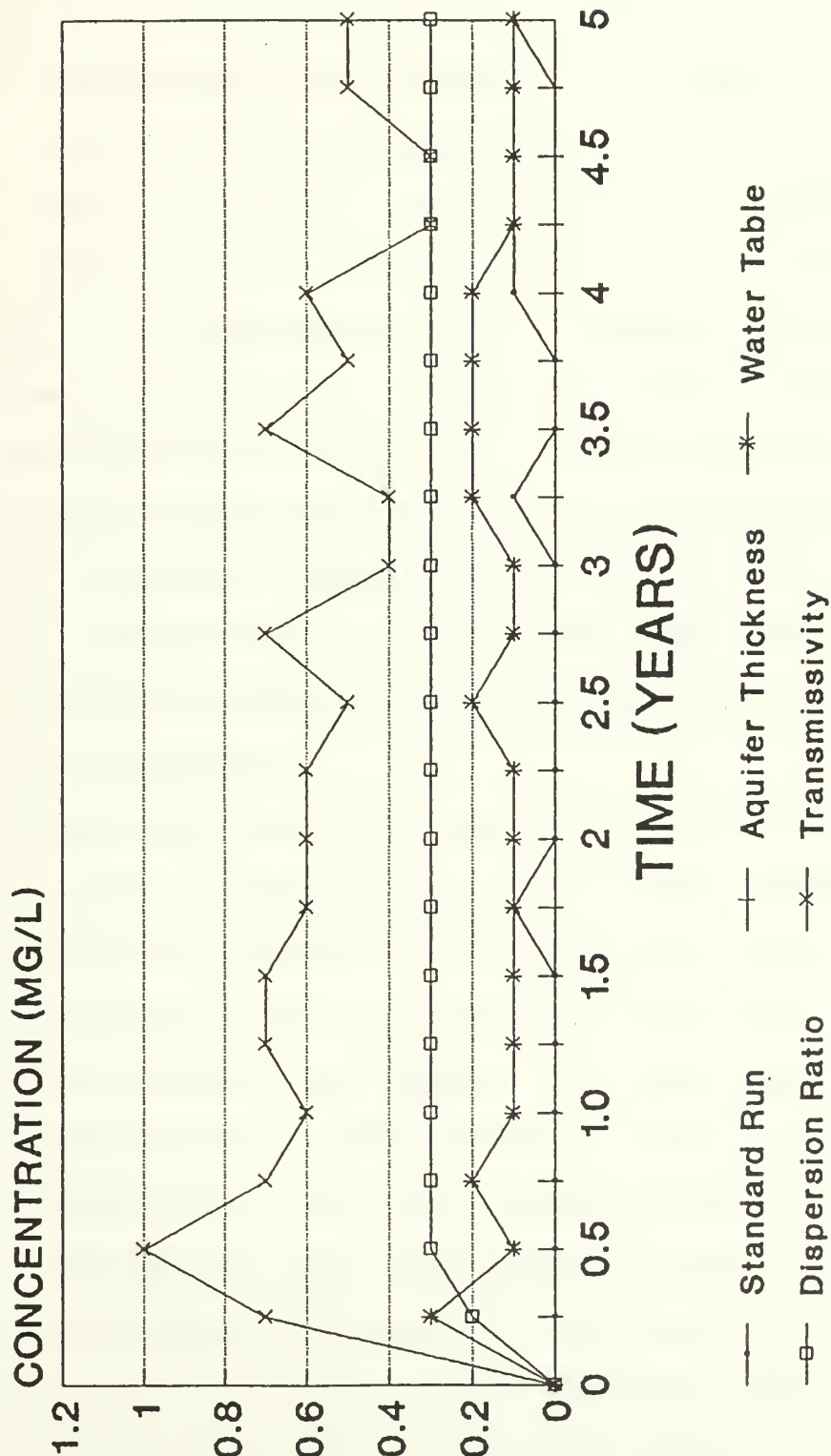


FIGURE 31 Observation Point One - Comparing results of all test runs over the entire pumping period.

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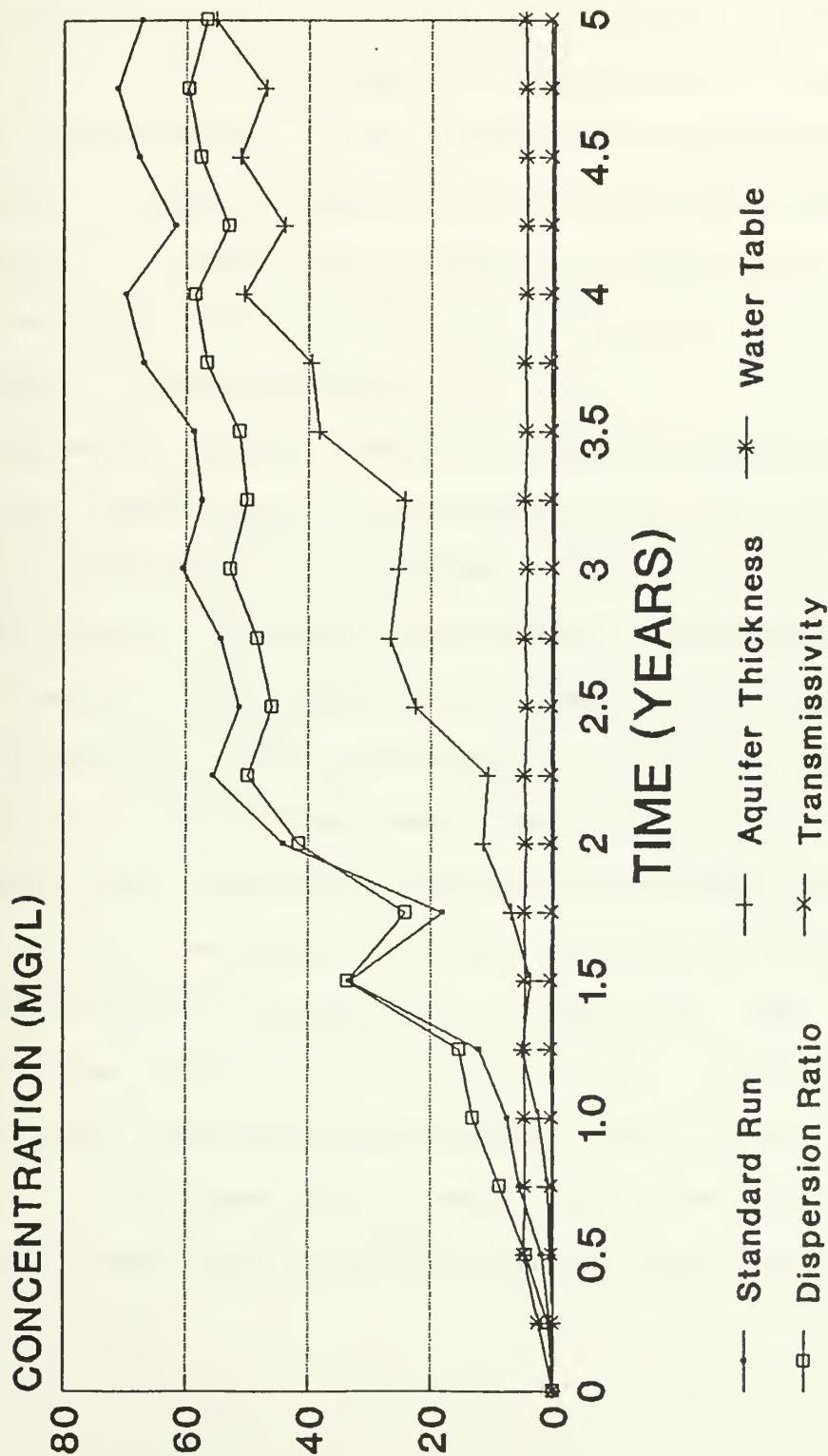
1955

For all test runs, concentrations remain low at this observation point, at less than 1 mg/L. However, while most concentration averages are below or equal to 0.3 mg/L, the concentration for the run in which transmissivity was varied averages twice that, or 0.6 mg/L. While this may not appear to be significant, due to the low overall levels, it does show that transmissivity is the controlling factor at observation point one, in that when transmissivity is decreased, the concentration increases. Referring back to figure 30, the concentration grids for test run number 5 show that with a lower transmissivity, the plume spreads or disperses laterally to the gradient instead of parallel to it. Knowing this, it is not surprising that the concentration would be higher at observation point one when the transmissivity is decreased.

Figure 32 shows the results at observation point two. This location was selected to look at the effects of the withdrawal wells combined with the effects of a constant-head boundary. Because this observation point is located down-gradient of Site A, this will also influence the results. The graph shows that the overall concentrations are much higher at this location than at observation point one. This is an expected effect of gradient on migration. During the 5 year time period, the concentrations of most test runs increased to roughly 60 mg/L after five years. However, two of the runs (transmissivity and water table height) increase for the first six months, then level off at 0.5 and 5 mg/L respectively.



## Comparing Results at Observation Point 2



**FIGURE 32** Observation Point Two - Comparing results of all test runs over the entire pumping period.



When the gradient or water table height is increased, the plume is pulled toward the Hood Canal (bottom of the grid). Because this observation point is located so far to the left of the site (2800 feet), it makes sense that concentrations for test run number 4 (water table height) would decrease with an increase in gradient. In fact, any increase in contaminant levels at all should be due mainly to diffusion. The same holds true for test run number 5 (transmissivity).

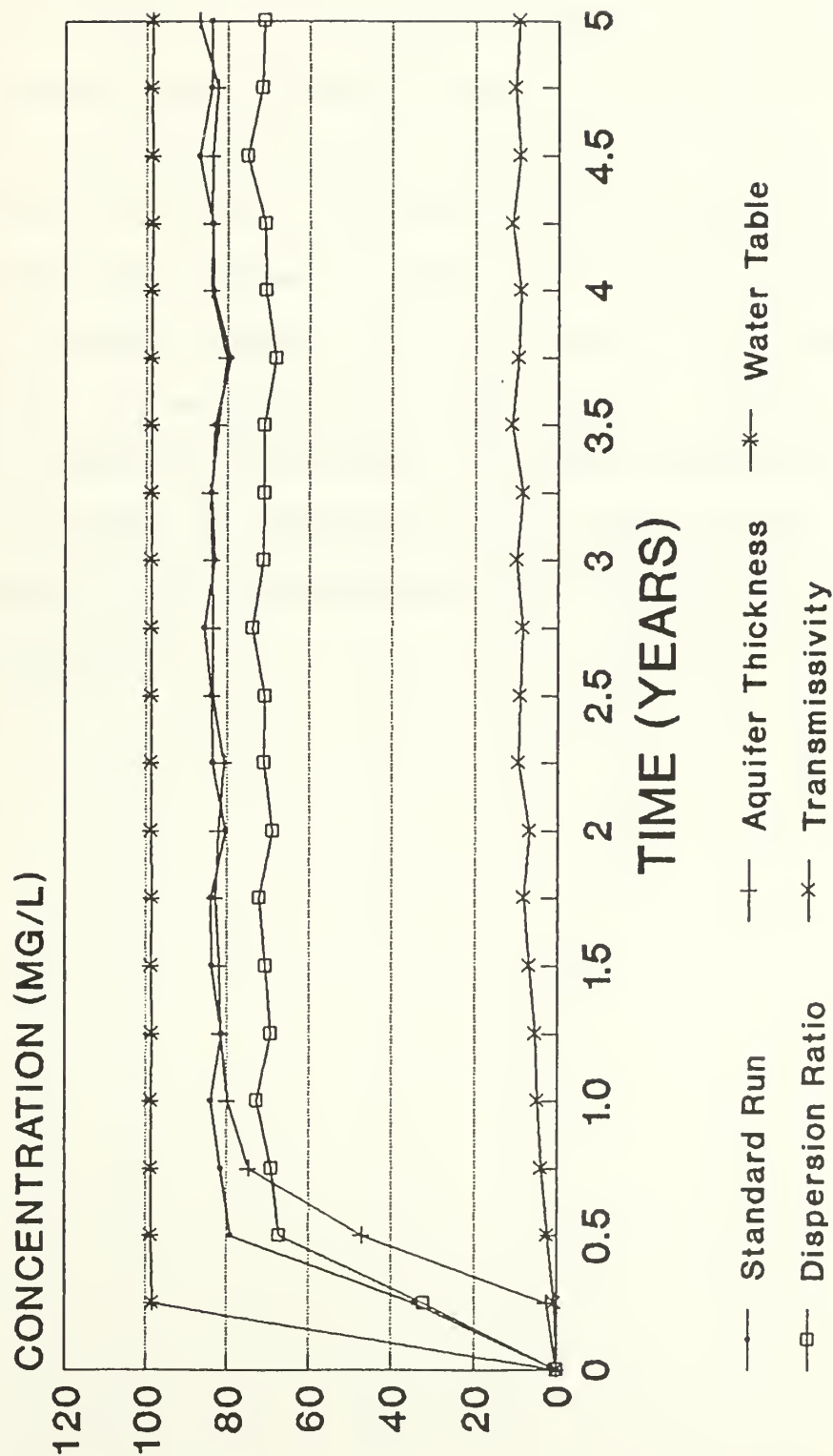
Observation Point three is located down-gradient from Site A, so that migration can be examined without the influence of the wells or constant-head boundaries. Figure 33 shows the results at this location. As shown, the highest concentrations occur when the water table height is increased. This is expected, and was shown earlier in the concentration grids for that test run (figure 29). During other test runs, concentrations increase during the first six months, as with observation point two, then level off at an average of 75 mg/L. However, the run in which transmissivity was decreased is an exception. Here, the concentration reached no more than 10 mg/L. Referring to the concentration grids for that test run, this is also an expected result. A low transmissivity would limit the amount of contaminant that would reach this observation point.





# MODELING SITE A

## Comparing Results at Observation Point 3



**FIGURE 33** Observation Point Three - Comparing results of all test runs over the entire pumping period.



The final graph, figure 34, shows the results at observation point four. This point was chosen to illustrate the effects of a constant-head boundary, without the influence of the wells. As shown, the concentration reached in most runs is equal to or less than 5 mg/L. The exception here is the run in which the water table height was increased. Although the concentration levels off at the same time increment, after the first six months, it levels off at roughly 25 mg/L, or five times the concentration of the other runs. Since observation point four is located more down-gradient than any other point, a higher concentration would be expected here with an increase in water table height. This also corresponds to the concentration grids for test run number 4, shown in figure 29.



# MODELING SITE A

## Comparing Results at Observation Point 4

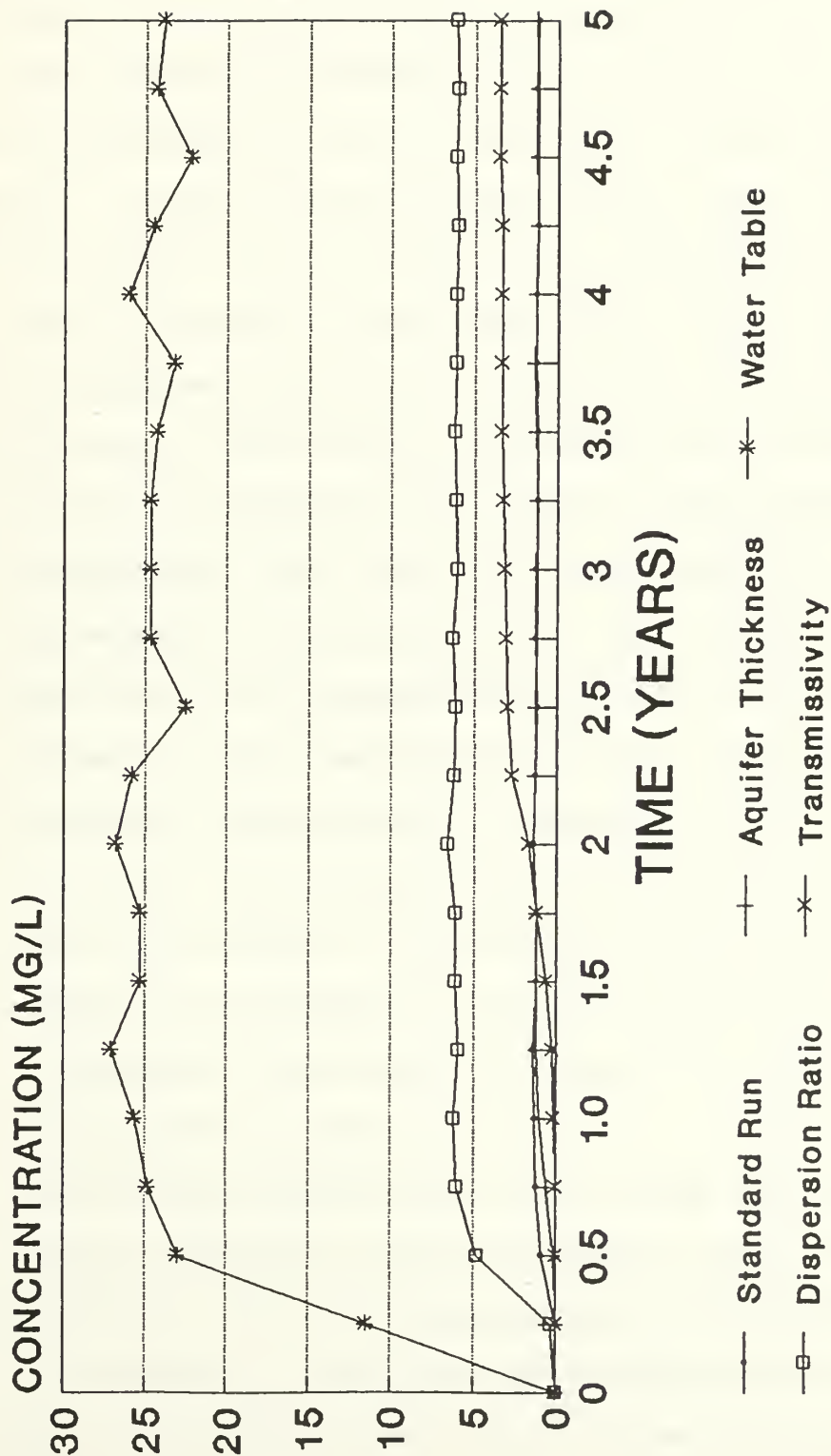


FIGURE 34 Observation Point Four - Comparing results of all test runs over the entire pumping period.



### Summary of model results for Site A

After examining the output files for all test runs, transmissivity and water table height (or gradient) are found to be the two most sensitive factors controlling migration at Site A. A lower transmissivity caused a decrease in migration, with one exception. In the vicinity of the Vinland wells, the concentrations were slightly elevated when this parameter was decreased. But the overall levels were still under 1 mg/L. Because the wells are located at the same elevation as Site A, or only slightly lower, the effects of diffusion would result in the increased levels, particularly with a lower transmissivity.

On the other hand, when the water table height was increased, the migration also increased. The only exception is when both area wells and a constant-head boundary influence migration. However, this observation point was located at some distance from Site A, and at the same elevation as the site, so an increase in water table height would have little influence. Because of the large changes in concentration that occur when water table height is increased, it appears to have the strongest influence on migration from Site A, and should be examined in detail when evaluating the site.

The concentration grids for test runs 2 and 3 (dispersion ratio and aquifer thickness) were surprising in that varying these values did not effect the general shape and direction of the plume. In addition, at the four observation points, the concentrations for these runs were close to the contaminant





levels found in the standard run. Therefore, variations in the dispersion ratio or aquifer thickness will not strongly effect contaminant migration, if at all.

## DISCUSSION

### Model Applicability to Site A

Going through this groundwater model was valuable because it provided an easy way to vary different aquifer characteristics and see the effect on contaminant migration. However, if the objective had been to specifically simulate the actual migration from Site A and obtain true contaminant levels, additional information would be required.

First, precise soil and hydraulic data must be obtained. A range of possible values for any one parameter would not be acceptable input data. Secondly, the aquifer's true no-flow boundaries must be mapped for accurate model simulation. Finally, accurate initial pollutant concentrations at the site must be obtained and a time period must be chosen to project contaminant migration.

Unfortunately, even with all this additional information, the resulting concentrations would still be inaccurate because USGS-MOC does not take the possible chemical and physical reactions (i.e. adsorption, degradation) of each contaminant into account. However, if enough is known about the behavior of the specific pollutants, numerical relationships could be developed to account for these reactions and then applied to the model output.



If all the necessary adjustments were made to account for contaminant behavior, the resulting concentrations would be close to simulating the actual migration patterns. While using USGS-MOC alone may not provide accurate results, I believe it does provide a good first look at the potential pollutant migration from the site.

#### Fate of Contaminants

The only contaminant consistently detected in soil samples both on and adjacent to Site A was RDX. Because of this compound's low solubility and sorption coefficient, I believe that while the bulk of RDX disposed of at the site will remain in the soil media, this compound has the highest potential for migration in groundwater. Levels of RDX were found in surface and groundwater samples, although the concentrations were extremely low.

TNT was detected at high concentrations in the surface soil samples at the site, but other samples (surface and subsurface) show low levels, if any. Concentrations of TNT were also found in surface water samples, but at low levels as well. Although TNT was not detected in groundwater, I believe there is potential for this compound to migrate through both surface and groundwater due to its high solubility and low desorption coefficient.

Although the phthalates were detected in only a few soil samples (none were found in water samples), they were consistently detected in plant tissue at the site. Because of their high volatility and low solubility, I believe



bioaccumulation would be the only potential for migration from Site A, and even then it would be limited to the flora in the immediate area.

Zinc was detected in all soil samples at high concentrations, and also found at slight levels in surface water. Because zinc is insoluble, this compound will remain in the soil media with little chance for migration.

#### The RI Process

After going through the RI process, I have made the following observations. First, when examining a hazardous waste site, extreme care must be taken to ensure that the evaluation is as accurate as possible. To accomplish this, sampling must be detailed and the data analysis must be specific, which is more difficult than it appears. When most contaminants were disposed of at these sites, the words "hazardous waste" were practically non-existent. Therefore, very few, if any, records were kept regarding the waste materials and the quantities discarded, as is the case for Site A. This results in a lack of raw data, which in turn makes the evaluation less reliable, not only effecting the outcome of the RI, but also effecting the FS portion of the clean up process. Because the development of remediation alternatives depends on the data collected and analyzed, weaknesses in the evaluation of the site are carried over to the Feasibility Study.

Secondly, because extensive field sampling is expensive and time-consuming, computer modeling can be used to supplement



sampling and assist in developing a picture of the potential for contaminant migration. While modeling, itself, will not result in a complete site evaluation, it is an excellent way to vary the unknown parameters and examine the effects of these changes on contaminant migration. This approach can save valuable time by showing what the critical parameters are and where future efforts should be concentrated.

I believe the existing RI process is well-organized and adequate to carry out its purpose. However, the accuracy and completeness of the final RI is a function of the complexity of the site being evaluated. Obtaining an RI with a high degree of confidence requires expenditure of both time and money. Judgement must be used to find a balance between expenditure and the detail of accuracy of the final report, particularly with a more complex site.

#### CONCLUSIONS

The objective of this study was to gain experience on the RI process. Data from an actual hazardous waste site (Site A) was necessary to carry out this study. The effort involved obtaining information of the behavior of the contaminants and the hydrogeological and surface water characteristics at a hazardous waste site. A second goal was to gain experience with application of a groundwater flow computer model, USGS-MOC, to evaluate contaminant transport from Site A. The following conclusions and results from this study are summarized for Site A. First:







1. Contamination is present in soil, surface water, and groundwater, with the majority found in the soil media.
2. Contaminant concentrations in the soil adjacent to Site A are the result of dust movement and/the heavy traffic involved in operations conducted at the site.
3. Contaminant migration in surface water is toward the stormwater discharge area; rates are unknown.
4. Contamination is present in groundwater, but rates of migration are unknown.

General conclusions for the entire exercise are:

1. Computer modeling can provide a way to vary unknown parameters and examine the effects on contaminant migration.
2. Although accurate concentrations cannot be obtained by using USGS-MOC, it does provide a good first look at contaminant migration.
3. To minimize the limitations of the existing RI process, field sampling and analysis should be coupled with computer modeling, when evaluating a hazardous waste site.
4. The existing RI process is well-organized, but problems with complexity of compounds makes it very costly and time-consuming to characterize a site with a high degree of confidence.



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# **APPENDIX 1**

## **Chronology of Events involving Site A**





CHRONOLOGY OF SITE A

- 1944 U.S. Naval Magazine Facility, Bangor is established as a transfer point for ordnance.
- 1958 Demilitarization of ordnance is added to Bangor's mission.
- 1962 March, Site A is established as an ammunition burning and detonation site.
- 1965-1967 An incinerator for small arms and dangerous pyrotechnic items, and a shielded blast pit for TNT detonation was added to Site A. In addition, several pits, trenches, and/barrel storage areas were added.
- 1966-1970 Demilitarization peaks due to Vietnam.
- 1971 500 cy of material with TNT and RDX was removed from Site F and burned with fuel oil and scrap lumber at Site A.
- 1975 Most activities at Site A ceased, as the result of concerns by the Navy and U.S.G.S.
- 1977 Demilitarizing operation buildings were demolished and burned at Site A.
- 1978 The Navy begins Assessment and Control of Installation Pollutants (ACIP) program to evaluate waste disposal sites at SUBASE, including Site A.
- 1978-1979 Revegetation of Site A.
- 1977 Navy convenes a combined local task force to identify sites as sources of potential pollution.
- 1977-1986 Limited testing of materials is conducted two to three times a year at Site A.  
340 soil samples are collected from Site A, most samples are taken within a depth of 4 feet.
- 1978-1984 261 water samples are collected from Site A and vicinity by SUBASE personnel.
- 1980 Cessation of on-site excavations at Site A.
- 1980 September, Navy initiates (NACIP) in response to CERCLA.
- 1980-1988 286 water quality samples have been collected at Site A and the vicinity.



- 1981 Initial Assessment Study (IAS) is conducted on Site A as part of NACIP.
- 1983 Navy constructs a diversion structure to route local surface flows to the stormwater discharge area, where water infiltrates the ground before discharge to the Hood Canal.
- 1984 Navy contracts to develop a POA and conduct verification and characterization studies of 11 sites, including Site A.
- 1984-1985 Samples of clams and oysters on Hood Canal are analyzed for TNT, RDX, otto fuel, and/picric acid, no detectable levels of TNT or RDX are found.
- 1985 The report is issued by the contractors.
- 1986 The characterization study, conducted under NACIP is conducted.
- 1986 Congress enacts SARA, so the Navy suspends further NACIP activity and phases in RI/FS programs.
- 1987 EPA adds Site A to the NPL list and RI/FS scoping is initiated.
- 1988 April, A current situation report is completed analyzing existing information, identifying information and data gaps, and evaluating interim remedial measures (IRM).
- 1991 Official RI/FS completed. The results have not been made available to the author.



# APPENDIX 2

Sample Input Data File  
for Computer Model  
USGS-MOC



TITLE: SITE A TEST NO. 1 (5 WELLS, DISPERSION RATIO 0.3,  
TRANSMISSIVITY 0.14, AQUIFER THICKNESS 25, WATER TABLE 50)

1 1 9 113200 1 7 5 100 5 9 2 10 0 0 1  
0

5.0001 0.25 100. 0. 0. 0. 800. 800. 0.3 0.50 1.

5 5

5 6

6 6

7 6

5 8

3 3 0.01

2 4 10.0

2 5 0.01

3 6 10.0

2 6 0.01

0 0.14

0 25.0

0 0.0

1 1.0

000000000

022222220

000000000

000001000

000001000

000000000

000000000

000000000

000000000

022222220

000000000

2 1.0 0.0 0.0 0

1 1.0 100.0 0.0 0

1 1.0

0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 80. 80. 80. 80. 80. 80. 80. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 55. 0. 0. 0.

0. 0. 0. 0. 0. 50. 0. 0. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0.

0 0.0





CARD NO. 1

TITLE: SITE A TEST NO. 5  
 (5 WELLS, DISPERSION RATIO 0.3,  
 TRANSMISSIVITY 0.14, AQUIFER  
 THICKNESS 25, WATER TABLE 50)

Title and description of  
 the problem to be  
 modeled.

CARD NO. 2

- |      |  |
|------|--|
| 1    | Maximum number of time steps in the pumping period.                                  |
| 1    | Number of pumping periods.   |
| 9    | Number of nodes in the X direction.  |
| 11   | Number of nodes in the Y direction.  |
| 3200 | Maximum number of available particles, maximum is 3200.                              |
| 1    | Number of time steps between printouts of hydraulic and chemical output data.        |
| 7    | Number of iteration parameters, must be between 4 and 7, usually set at 7.           |
| 4    | Number of observation points in the problem, to be defined in data set 1.            |
| 100  | Maximum permitted number of iterations.  |
| 5    | Number of withdrawal or injection wells in the problem, to be defined in data set 2. |
| 9    | Initial number of particles per node, 9 is used for uniformity.                      |
| 2    | Number of node identification codes required, to be defined in data set 6.           |
| 10   | Particle movement interval for printing chemical output data.                        |
| 0    | Option for printing computed velocity, 0 = do not print.                             |
| 0    | Option for printing computed dispersion equation coefficients, 0 = do not print.     |
| 1    | Option for printing computed changes in concentration, 1 = print                     |
| 0    | Option for printing punch velocity data, 0 = do not                                  |



print.

### CARD NO. 3

5	Pumping period in years when running problem
.0001	Convergence criteria.
.25	Effective porosity of soil.
100	Longitudinal dispersivity of porous medium.
0	Storage coefficient, set equal to 0 for steady flow.
0	Time increment multiplier for transient flow problems, equal to 0 if steady state.
0	Size of initial time step in seconds, equal to 0 if steady state.
800	Width of each finite difference cell in the X direction.
800	Width of each finite difference cell in the Y direction.
0.3	Dispersivity ratio, transverse to longitudinal dispersivity.
0.50	Maximum cell distance per particle move, usually set equal to 0.5, limit is 1.
1	Anisotropy factor.

### DATA SET NO. 1

3 4	
2 7	X and Y coordinates of the observation points.
5 8	
8 9	

### DATA SET NO. 2

3 3	0.01	
2 4	10.0	X and Y coordinates of the withdrawal or injection
2 5	0.01	wells. In this case, since all wells are
3 6	10.0	withdrawal, the next number is the rate of
2 6	0.01	pumping, in cf/sec.

### DATA SET NO. 3

0 0.14	Parameter card for transmissivity. If assumed
--------	---



homogeneous throughout the problem grid, it is set equal to 0, with the transmissivity following.

#### DATA SET NO. 4

0 25.0            Parameter card for aquifer thickness, assumed to be homogeneous.

#### DATA SET NO. 5

0 0.0            Parameter card for aquifer recharge/discharge.

#### DATA SET NO. 6

1 1.0            Parameter card for node identification codes.

000000000  
022222220       Node identification matrix for the problem  
000000000       grid. The number 2 shows the location of the  
000001000       constant head boundaries. The number 1 shows  
000001000       the location of the source, or Site A.  
000000000  
000000000  
000000000  
000000000  
000000000  
022222220  
000000000

#### DATA SET NO. 7

2            Node identification instructions. This number is the  
             node identification code used in the matrix in data set  
             no. 6.

1.0           Multiplication factors if needed.

0.0           Initial concentration of contaminant in source or  
             constant head boundaries.

0.0           Recharge values if needed.

0            Override values if needed. This is used to preserve the  
             values for recharge set in data set no. 5. It is equal  
             to 0 if there is no recharge.

1  
1.0           These are the same as defined above. Initial  
100.0          concentration is set to 100.0 here since these  
0.0           figures represent Site A.  
0

#### DATA SET NO. 8

1 1.0            Parameter card for water table elevations.



0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	80.	80.	80.	80.	80.	80.	80.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	55.	0.	0.	0.
0.	0.	0.	0.	0.	50.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.

Water table elevation matrix. Values must be set for all constant head boundaries and source of contamination. The bottom constant head boundary is set to 0 in this case because it represents the Hood Canal.

#### DATA SET NO. 9

0 0.0            Parameter card for initial concentration in the  
                  aquifer. It is set equal to 0 since the only  
 source of contamination is from Site A.





# APPENDIX 3

Sample Output File  
for Computer Model  
USGS-MOC



# U.S.G.S. METHOD-OF-CHARACTERISTICS MODEL FOR SOLUTE TRANSPORT IN GROUND WATER

THIS VERSION IS DISTRIBUTED BY INTERNATIONAL GROUND WATER MODELING CENTER

HOLCOMB RESEARCH INSTITUTE, BUTLER UNIV., INDIANAPOLIS, IN 46208, USA

TITLE: SITE A TEST NO. 1 (5 WELLS, DISPERSION RATIO 0.3, TRANSMISSIVITY 0.14, AQUIFER THICKNESS 25, WATER TABLE 50)

## INPUT DATA

### GRID DESCRIPTORS

NX	(NUMBER OF COLUMNS)	=	9
NY	(NUMBER OF ROWS)	=	11
XDEL	(X-DISTANCE IN FEET)	=	800.0
YDEL	(Y-DISTANCE IN FEET)	=	800.0

### TIME PARAMETERS

NTIM	(MAX. NO. OF TIME STEPS)	=	1
NPMP	(NO. OF PUMPING PERIODS)	=	1
PINT	(PUMPING PERIOD IN YEARS)	=	5.000
TIMX	(TIME INCREMENT MULTIPLIER)	=	.00
TINIT	(INITIAL TIME STEP IN SEC.)	=	0.

### HYDROLOGIC AND CHEMICAL PARAMETERS

S	(STORAGE COEFFICIENT)	=	.000000
POROS	(EFFECTIVE POROSITY)	=	.25
BETA	(CHARACTERISTIC LENGTH)	=	100.0
DLTRAT	(RATIO OF TRANSVERSE TO LONGITUDINAL DISPERSIVITY)	=	.30
ANFCTR	(RATIO OF T-YY TO T-XX)	=	1.000000

### EXECUTION PARAMETERS

NITP	(NO. OF ITERATION PARAMETERS)	=	7
TOL	(CONVERGENCE CRITERIA - ADIP)	=	.0001
ITMAX	(MAX.NO.OF ITERATIONS - ADIP)	=	100
CELDIS	(MAX.CELL DISTANCE PER MOVE OF PARTICLES - M.O.C.)	=	.500
NPMAX	(MAX. NO. OF PARTICLES)	=	3200
NPTPND	(NO. PARTICLES PER NODE)	=	9

### PROGRAM OPTIONS

NPNT	(TIME STEP INTERVAL FOR COMPLETE PRINTOUT)	=	1
NPNTMV	(MOVE INTERVAL FOR CHEM. CONCENTRATION PRINTOUT)	=	10
NPNTVL	(PRINT OPTION-VELOCITY		



	0=NO; 1=FIRST TIME STEP; 2=ALL TIME STEPS)	=	0
NPNTD	(PRINT OPTION-DISP.COEF. 0=NO; 1=FIRST TIME STEP; 2=ALL TIME STEPS)	=	0
NUMOBS	(NO. OF OBSERVATION WELLS FOR HYDROGRAPH PRINTOUT)	=	4
NREC	(NO. OF PUMPING WELLS)	=	5
NCODES	(FOR NODE IDENT.)	=	2
NPNCHV	(PUNCH VELOCITIES)	=	0
NPDEL	(PRINT OPT.-CONC. CHANGE)	=	1

## STEADY-STATE FLOW

TIME INTERVAL (IN SEC) FOR SOLUTE-TRANSPORT SIMULATION = .15779E+09

## LOCATION OF OBSERVATION WELLS

NO.	X	Y
1	3	4
2	2	7
3	5	8
4	8	9

LOCATION OF PUMPING WELLS			
X	Y	RATE (IN CFS)	CONC.
1	1	100	100
2	2	200	200
3	3	300	300
4	4	400	400
5	5	500	500
6	6	600	600
7	7	700	700
8	8	800	800
9	9	900	900
10	10	1000	1000

```

3    3          .0100          .00
2    4      10.0000          .00
2    5          .0100          .00
3    6      10.0000          .00
2    6          .0100          .00
AREA OF ONE CELL =      .6400E+06

```

X-Y SPACING:

800.00

800.00

## TRANSMISSIVITY MAP (FT\*FT/SEC)

[illegible]













[illegible]

## WATER TABLE

[illegible]

## CONCENTRATION

```

NUMBER OF TIME STEPS =      0
      TIME(SECONDS) =    .00000
CHEM.TIME(SECONDS) =    .00000E+00
CHEM.TIME(DAYS) =    .00000E+00
      TIME(YEARS) =    .00000E+00
CHEM.TIME(YEARS) =    .00000E+00
NO. MOVES COMPLETED =      0

```

[illegible]

## HEAD DISTRIBUTION - ROW

```

NUMBER OF TIME STEPS =      1
      TIME(SECONDS) =    .15779E+09
      TIME(DAYS) =    .18263E+04
      TIME(YEARS) =    .50000E+01

```

0 0 0 0 0 0 0 0 0 0



0	0	80	80	80	80	80	80	80	0
0	0	43	51	58	63	67	68	68	0
0	0	-1	24	38	48	55	57	57	0
0	0	0	7	22	36	50	47	46	0
0	0	-6	-16	9	23	32	35	35	0
0	0	-3	-3	6	15	21	24	25	0
0	0	-1	0	4	9	13	15	16	0
0	0	0	0	2	4	6	7	8	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

## DRAWDOWN

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	-42	-50	-57	-62	-66	-67	-67	-67	0
0	2	-23	-37	-47	0	-56	-56	-56	0
0	1	-6	-21	-35	0	-46	-45	-45	0
0	7	17	-8	-22	-31	-34	-34	-34	0
0	4	4	-5	-14	-20	-23	-24	-24	0
0	2	0	-3	-8	-12	-14	-15	-15	0
0	0	0	-1	-3	-5	-6	-7	-7	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

CUMULATIVE MASS BALANCE -- (IN FT\*\*3)

RECHARGE AND INJECTION	=	.00000E+00
PUMPAGE AND E-T WITHDRAWAL	=	.31605E+10
CUMULATIVE NET PUMPAGE	=	.31605E+10
WATER RELEASE FROM STORAGE	=	.00000E+00
LEAKAGE INTO AQUIFER	=	.38022E+10
LEAKAGE OUT OF AQUIFER	=	-.64172E+09
CUMULATIVE NET LEAKAGE	=	.31605E+10
MASS BALANCE RESIDUAL	=	5888.0
ERROR (AS PERCENT)	=	.15486E-03

## RATE MASS BALANCE -- (IN C.F.S.)

LEAKAGE INTO AQUIFER	=	.24097E+02
LEAKAGE OUT OF AQUIFER	=	-.40670E+01
NET LEAKAGE (QNET)	=	.20030E+02
RECHARGE AND INJECTION	=	.00000E+00
PUMPAGE AND E-T WITHDRAWAL	=	.20030E+02
NET WITHDRAWAL (TPUM)	=	.20030E+02

## CONCENTRATION

NUMBER OF TIME STEPS	=	1
DELTA T	=	.15779E+09
TIME(SECONDS)	=	.15779E+09
CHEM.TIME(SECONDS)	=	.31812E+07
CHEM.TIME(DAYS)	=	.36820E+02
TIME(YEARS)	=	.50000E+01
CHEM.TIME(YEARS)	=	.10081E+00
NO. MOVES COMPLETED	=	10



0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	0	0	1	33	78	2	0	0
0	0	0	2	11	61	74	11	0	0
0	0	0	0	2	11	15	1	0	0
0	0	0	0	0	1	1	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

## CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .31812E+07  
 CHEM.TIME(DAYS) = .36820E+02  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .10081E+00  
 NO. MOVES COMPLETED = 10

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	3	0	0	0
0	0	0	0	0	33	78	1	0	0
0	0	0	1	11	60	74	10	0	0
0	0	0	0	1	11	14	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .63624E+07  
 CHEM.TIME(DAYS) = .73639E+02  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .20161E+00  
 NO. MOVES COMPLETED = 20

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	0	0	3	33	94	3	0	0
0	0	1	16	36	85	90	5	0	0





0	0	0	12	49	71	71	4	0	0
0	0	0	1	3	7	21	1	0	0
0	0	0	0	0	1	1	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

## CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .63624E+07  
 CHEM.TIME(DAYS) = .73639E+02  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .20161E+00  
 NO. MOVES COMPLETED = 20

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	3	0	0	0
0	0	0	0	2	33	94	2	0	0
0	0	0	15	36	85	90	5	0	0
0	0	0	11	49	70	70	3	0	0
0	0	0	0	3	6	21	0	0	0
0	0	0	0	0	1	1	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .95436E+07  
 CHEM.TIME(DAYS) = .11046E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .30242E+00  
 NO. MOVES COMPLETED = 30

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	1	1	3	37	95	3	0	0
0	0	2	27	35	89	93	16	0	0
0	0	1	26	70	84	73	8	1	0
0	0	0	2	10	51	44	4	1	0
0	0	0	0	2	6	4	1	0	0
0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0	0

## CHANGE IN CONCENTRATION



NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .95436E+07  
 CHEM.TIME(DAYS) = .11046E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .30242E+00  
 NO. MOVES COMPLETED = 30

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	3	0	0	0
0	0	0	1	3	37	94	2	0	0
0	0	1	26	34	89	92	15	0	0
0	0	0	25	69	84	72	8	0	0
0	0	0	2	9	50	44	4	0	0
0	0	0	0	2	6	4	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

#### CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .12725E+08  
 CHEM.TIME(DAYS) = .14728E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .40323E+00  
 NO. MOVES COMPLETED = 40

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	1	2	4	31	95	3	0	0
0	0	2	23	44	90	93	6	0	0
0	0	1	46	79	88	87	8	1	0
0	0	0	6	16	72	59	7	1	0
0	0	0	1	6	39	8	3	0	0
0	0	0	0	1	3	3	1	0	0
0	0	0	0	0	0	0	0	0	0

#### CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .12725E+08  
 CHEM.TIME(DAYS) = .14728E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .40323E+00



NO. MOVES COMPLETED = 40

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	3	0	0	0
0	0	1	1	3	31	94	2	0	0
0	0	2	23	43	89	93	6	0	0
0	0	0	45	78	87	87	8	0	0
0	0	0	5	16	72	58	6	0	0
0	0	0	0	5	39	7	2	0	0
0	0	0	0	0	3	3	0	0	0
0	0	0	0	0	0	0	0	0	0

# CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .15906E+08  
 CHEM.TIME(DAYS) = .18410E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .50403E+00  
 NO. MOVES COMPLETED = 50

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	2	2	4	32	95	3	0	0
0	0	4	26	40	90	93	15	0	0
0	0	2	65	82	89	88	8	1	0
0	0	1	11	23	79	59	8	1	0
0	0	0	1	12	57	10	5	1	0
0	0	0	0	2	7	7	2	0	0
0	0	0	0	0	0	0	0	0	0

TIME VERSUS HEAD AND CONCENTRATION AT SELECTED OBSERVATION POINTS

PUMPING PERIOD NO. 1

## STEADY-STATE SOLUTION

HEAD (FT)	CONC. (MG/L)	OBS.WELL NO.	X	Y	N
		TIME (YEARS)			
		1	3	4	
.0	.0	.000			0
23.7	.0	.010			1
					2



23.7	.0	.020	3
23.7	.0	.030	4
23.7	.0	.040	5
23.7	.0	.050	6
23.7	.0	.060	7
23.7	.0	.071	8
23.7	.0	.081	9
23.7	.0	.091	10
23.7	-.1	.101	11
23.7	-.1	.111	12
23.7	-.1	.121	13
23.7	-.1	.131	14
23.7	-.1	.141	15
23.7	-.1	.151	16
23.7	-.1	.161	17
23.7	-.1	.171	18
23.7	-.1	.181	19
23.7	-.1	.192	20
23.7	-.1	.202	21
23.7	.0	.212	22
23.7	.0	.222	23
23.7	.0	.232	24
23.7	.0	.242	25
23.7	.0	.252	26
23.7	.0	.262	27
23.7	.0	.272	28





23.7	.0	.282			29
23.7	.0	.292			30
23.7	.0	.302			31
23.7	.0	.313			32
23.7	.0	.323			33
23.7	.0	.333			34
23.7	.0	.343			35
23.7	.0	.353			36
23.7	.0	.363			37
23.7	.0	.373			38
23.7	.0	.383			39
23.7	.0	.393			40
23.7	.0	.403			41
23.7	.0	.413			42
23.7	.0	.423			43
23.7	.0	.433			44
23.7	.0	.444			45
23.7	.0	.454			46
23.7	.0	.464			47
23.7	.0	.474			48
23.7	.0	.484			49
23.7	.0	.494			50
23.7	.0	.504			N
HEAD (FT)	CONC. (MG/L)	OBS. WELL NO.	TIME (YEARS)	X	Y
		2	2	7	



.0	.0	.000	1
-4.1	.0	.010	2
-4.1	.0	.020	3
-4.1	.0	.030	4
-4.1	.0	.040	5
-4.1	.0	.050	6
-4.1	.0	.060	7
-4.1	.0	.071	8
-4.1	.0	.081	9
-4.1	.0	.091	10
-4.1	.0	.101	11
-4.1	.0	.111	12
-4.1	.0	.121	13
-4.1	.0	.131	14
-4.1	.0	.141	15
-4.1	.0	.151	16
-4.1	.0	.161	17
-4.1	.0	.171	18
-4.1	.0	.181	19
-4.1	.0	.192	20
-4.1	.1	.202	21
-4.1	.1	.212	22
-4.1	.1	.222	23
-4.1	.1	.232	24
-4.1	.4	.242	25
-4.1	.4	.252	26



-4.1	.5	.262	27
-4.1	.6	.272	28
-4.1	.7	.282	29
-4.1	.7	.292	30
-4.1	.8	.302	31
-4.1	.9	.313	32
-4.1	.9	.323	33
-4.1	.7	.333	34
-4.1	.8	.343	35
-4.1	.9	.353	36
-4.1	1.0	.363	37
-4.1	1.1	.373	38
-4.1	1.2	.383	39
-4.1	.6	.393	40
-4.1	.6	.403	41
-4.1	.7	.413	42
-4.1	.8	.423	43
-4.1	.9	.433	44
-4.1	1.1	.444	45
-4.1	1.2	.454	46
-4.1	1.3	.464	47
-4.1	1.5	.474	48
-4.1	1.6	.484	49
-4.1	1.8	.494	50
-4.1	1.9	.504	
0 HEAD (FT)	OBS. WELL NO. CONC. (MG/L)	X TIME (YEARS)	Y N



3                      5                      8

.0	.0	.000	0
8.9	.0	.010	1
8.9	.0	.020	2
8.9	.0	.030	3
8.9	.0	.040	4
8.9	.0	.050	5
8.9	.1	.060	6
8.9	.2	.071	7
8.9	.2	.081	8
8.9	.6	.091	9
8.9	1.0	.101	10
8.9	1.2	.111	11
8.9	1.8	.121	12
8.9	2.0	.131	13
8.9	2.3	.141	14
8.9	3.1	.151	15
8.9	4.0	.161	16
8.9	4.3	.171	17
8.9	5.2	.181	18
8.9	6.0	.192	19
8.9	6.7	.202	20
8.9	10.3	.212	21
8.9	14.7	.222	22
8.9	20.5	.232	23
			24





8.9	24.5	.242	25
8.9	34.3	.252	26
8.9	37.2	.262	27
8.9	42.0	.272	28
8.9	47.1	.282	29
8.9	49.9	.292	30
8.9	50.6	.302	31
8.9	54.7	.313	32
8.9	55.6	.323	33
8.9	60.4	.333	34
8.9	63.6	.343	35
8.9	65.0	.353	36
8.9	66.8	.363	37
8.9	68.5	.373	38
8.9	70.1	.383	39
8.9	70.9	.393	40
8.9	72.1	.403	41
8.9	73.4	.413	42
8.9	74.6	.423	43
8.9	75.9	.433	44
8.9	76.5	.444	45
8.9	77.2	.454	46
8.9	78.0	.464	47
8.9	78.2	.474	48
8.9	78.4	.484	49
8.9	78.7	.494	50



8.9	79.2	.504			
0	OBS.	WELL NO.	X	Y	N
HEAD (FT)	CONC. (MG/L)	TIME (YEARS)			
		4	8	9	
					0
.0	.0	.000			1
7.6	.0	.010			2
7.6	.0	.020			3
7.6	.0	.030			4
7.6	.0	.040			5
7.6	.0	.050			6
7.6	.0	.060			7
7.6	.0	.071			8
7.6	.0	.081			9
7.6	.0	.091			10
7.6	.0	.101			11
7.6	.0	.111			12
7.6	.0	.121			13
7.6	.0	.131			14
7.6	.0	.141			15
7.6	.0	.151			16
7.6	.0	.161			17
7.6	.0	.171			18
7.6	.0	.181			19
7.6	.0	.192			20
7.6	.0	.202			21
7.6	.0	.212			22



7.6	.0	.222	23
7.6	.0	.232	24
7.6	.0	.242	25
7.6	.0	.252	26
7.6	.0	.262	27
7.6	.1	.272	28
7.6	.1	.282	29
7.6	.1	.292	30
7.6	.1	.302	31
7.6	.1	.313	32
7.6	.2	.323	33
7.6	.2	.333	34
7.6	.2	.343	35
7.6	.3	.353	36
7.6	.3	.363	37
7.6	.3	.373	38
7.6	.5	.383	39
7.6	.5	.393	40
7.6	.5	.403	41
7.6	.6	.413	42
7.6	.6	.423	43
7.6	.7	.433	44
7.6	.7	.444	45
7.6	.7	.454	46
7.6	.8	.464	47
7.6	.8	.474	48



7.6 .8 .484

49

7.6 .9 .494

50

7.6 .9 .504

## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .19087E+08  
 CHEM.TIME(DAYS) = .22092E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .60484E+00  
 NO. MOVES COMPLETED = 60

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	2	2	4	37	95	3	0	0
0	0	4	33	36	90	94	7	0	0
0	0	4	64	83	89	88	9	1	0
0	0	1	19	28	80	51	8	1	0
0	0	0	2	44	69	13	7	1	0
0	0	0	0	16	28	10	4	1	0
0	0	0	0	0	0	0	0	0	0

## CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .19087E+08  
 CHEM.TIME(DAYS) = .22092E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .60484E+00  
 NO. MOVES COMPLETED = 60

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	2	0	0	0
0	0	2	1	3	37	94	3	0	0
0	0	4	32	35	90	93	6	0	0
0	0	3	63	83	89	87	8	0	0
0	0	1	18	28	80	50	7	0	0
0	0	0	2	43	69	13	6	1	0
0	0	0	0	15	27	9	4	0	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION





NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .22268E+08  
 CHEM.TIME(DAYS) = .25774E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .70564E+00  
 NO. MOVES COMPLETED = 70

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	2	2	3	31	95	9	0	0
0	0	4	28	45	90	93	7	0	0
0	0	5	74	84	90	88	8	1	0
0	0	1	23	33	82	48	7	1	0
0	0	0	6	65	74	15	7	1	0
0	0	0	0	44	48	12	5	1	0
0	0	0	0	0	0	0	0	0	0

## CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .22268E+08  
 CHEM.TIME(DAYS) = .25774E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .70564E+00  
 NO. MOVES COMPLETED = 70

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	3	0	0	0
0	0	2	2	3	30	94	9	0	0
0	0	4	28	44	89	93	6	0	0
0	0	5	73	84	89	87	8	0	0
0	0	1	23	33	81	48	7	0	0
0	0	0	6	64	74	14	7	1	0
0	0	0	0	44	48	12	5	1	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .25450E+08  
 CHEM.TIME(DAYS) = .29456E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .80645E+00



NO. MOVES COMPLETED = 80

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	2	2	4	34	95	3	0	0
0	0	5	31	38	90	93	15	0	0
0	0	5	75	84	89	88	8	1	0
0	0	4	27	38	82	51	8	1	0
0	0	1	8	70	77	15	7	1	0
0	0	0	1	60	57	15	6	1	0
0	0	0	0	0	0	0	0	0	0

CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .25450E+08  
 CHEM.TIME(DAYS) = .29456E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .80645E+00  
 NO. MOVES COMPLETED = 80

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	3	0	0	0
0	0	2	1	3	33	94	3	0	0
0	0	4	31	38	90	93	15	0	0
0	0	4	74	84	89	87	8	0	0
0	0	4	27	37	81	51	7	0	0
0	0	0	8	69	76	14	7	1	0
0	0	0	0	59	57	15	6	1	0
0	0	0	0	0	0	0	0	0	0

NPCELL

```

*****
***  6  6  6  7  6  8  9***
*** 13 21 18 14 15 18 18***
*** 18 25 20 15  9 16 19***
***  9 21 11 17  5 10 15***
***  9 17 16 16 16 15 21***
***  6 20 22  9 13 13 18***
*** 10  0  0 16 11 20 14***
***  8  6  6 25 10 18 17***
*** 10  9  9  9  9  9  9***
*****

```

CONCENTRATION

NUMBER OF TIME STEPS = 1



```

      DELTA T      = .15779E+09
      TIME(SECONDS) = .15779E+09
      CHEM.TIME(SECONDS) = .28631E+08
      CHEM.TIME(DAYS)   = .33138E+03
      TIME(YEARS)      = .50000E+01
      CHEM.TIME(YEARS)  = .90726E+00
      NO. MOVES COMPLETED = 90

```

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	4	0	0	0
0	0	2	2	5	44	87	3	0	0
0	0	5	25	53	81	85	8	0	0
0	0	5	71	86	89	88	13	1	0
0	0	6	28	59	80	64	9	1	0
0	0	1	9	71	77	27	7	1	0
0	0	0	2	64	66	16	7	1	0
0	0	0	0	0	0	0	0	0	0

## CHANGE IN CONCENTRATION

```

NUMBER OF TIME STEPS = 1
      DELTA T      = .15779E+09
      TIME(SECONDS) = .15779E+09
      CHEM.TIME(SECONDS) = .28631E+08
      CHEM.TIME(DAYS)   = .33138E+03
      TIME(YEARS)      = .50000E+01
      CHEM.TIME(YEARS)  = .90726E+00
      NO. MOVES COMPLETED = 90

```

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	1	1	4	43	86	3	0	0
0	0	4	25	53	81	85	8	0	0
0	0	4	70	85	88	87	13	0	0
0	0	6	27	59	80	64	9	1	0
0	0	0	8	71	76	26	7	1	0
0	0	0	2	64	66	15	6	1	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION

```

NUMBER OF TIME STEPS = 1
      DELTA T      = .15779E+09
      TIME(SECONDS) = .15779E+09
      CHEM.TIME(SECONDS) = .31812E+08
      CHEM.TIME(DAYS)   = .36820E+03
      TIME(YEARS)      = .50000E+01
      CHEM.TIME(YEARS)  = .10081E+01
      NO. MOVES COMPLETED = 100

```



0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	2	3	0	0	0
0	0	2	2	4	30	93	3	0	0
0	0	6	26	53	84	87	25	1	0
0	0	7	68	81	82	68	10	1	0
0	0	7	37	82	84	51	12	1	0
0	0	2	24	71	73	39	8	1	0
0	0	0	3	67	63	16	7	1	0
0	0	0	0	0	0	0	0	0	0

HEAD (FT)	CONC. (MG/L)	OBS. WELL NO.	X	Y	N
		TIME (YEARS)			
		1	3	4	
					0
.0	.0	.000			1
23.7	.0	.514			2
23.7	.0	.524			3
23.7	.0	.534			4
23.7	.0	.544			5
23.7	.0	.554			6
23.7	.0	.565			7
23.7	.0	.575			8
23.7	.0	.585			9
23.7	.0	.595			10
23.7	.0	.605			11
23.7	.0	.615			12
23.7	.0	.625			13
23.7	.0	.635			14
23.7	.0	.645			15
23.7	.0	.655			16





23.7	.0	.665	17
23.7	.0	.675	18
23.7	.0	.685	19
23.7	.0	.696	20
23.7	.0	.706	21
23.7	.0	.716	22
23.7	.0	.726	23
23.7	.0	.736	24
23.7	.0	.746	25
23.7	.0	.756	26
23.7	.0	.766	27
23.7	.0	.776	28
23.7	.0	.786	29
23.7	.0	.796	30
23.7	.0	.806	31
23.7	.0	.817	32
23.7	.0	.827	33
23.7	.0	.837	34
23.7	.0	.847	35
23.7	.0	.857	36
23.7	.1	.867	37
23.7	.1	.877	38
23.7	.1	.887	39
23.7	.1	.897	40
23.7	.1	.907	41
23.7	.1	.917	42



23.7	.0	.927				43
23.7	.0	.937				44
23.7	.0	.948				45
23.7	.0	.958				46
23.7	.0	.968				47
23.7	.0	.978				48
23.7	.0	.988				49
23.7	.0	.998				50
23.7	.0	1.008				
	OBS.	WELL NO.	X	Y		N
HEAD (FT)	CONC. (MG/L)	TIME (YEARS)				
		2	2	7		
.0	.0	.000				0
-4.1	2.1	.514				1
-4.1	2.2	.524				2
-4.1	2.2	.534				3
-4.1	2.3	.544				4
-4.1	2.4	.554				5
-4.1	2.4	.565				6
-4.1	2.6	.575				7
-4.1	2.7	.585				8
-4.1	3.5	.595				9
-4.1	3.6	.605				10
-4.1	3.9	.615				11
-4.1	4.0	.625				12
-4.1	4.7	.635				13
						14



-4.1	4.8	.645	15
-4.1	4.0	.655	16
-4.1	4.2	.665	17
-4.1	4.3	.675	18
-4.1	4.0	.685	19
-4.1	5.1	.696	20
-4.1	5.4	.706	21
-4.1	5.6	.716	22
-4.1	5.7	.726	23
-4.1	5.2	.736	24
-4.1	5.3	.746	25
-4.1	5.5	.756	26
-4.1	4.9	.766	27
-4.1	5.1	.776	28
-4.1	4.7	.786	29
-4.1	4.9	.796	30
-4.1	4.9	.806	31
-4.1	5.1	.817	32
-4.1	3.5	.827	33
-4.1	3.7	.837	34
-4.1	3.9	.847	35
-4.1	4.0	.857	36
-4.1	4.2	.867	37
-4.1	4.4	.877	38
-4.1	4.6	.887	39
-4.1	4.7	.897	40



-4.1	4.9	.907				41
-4.1	5.3	.917				42
-4.1	5.6	.927				43
-4.1	5.8	.937				44
-4.1	6.0	.948				45
-4.1	6.1	.958				46
-4.1	6.3	.968				47
-4.1	6.9	.978				48
-4.1	7.1	.988				49
-4.1	7.3	.998				50
-4.1	7.5	1.008				
			OBS. WELL NO.	X	Y	N
HEAD (FT)	CONC. (MG/L)	TIME (YEARS)				
			3	5	8	
.0	.0	.000				0
8.9	79.2	.514				1
8.9	79.3	.524				2
8.9	79.4	.534				3
8.9	79.6	.544				4
8.9	79.6	.554				5
8.9	79.7	.565				6
8.9	79.9	.575				7
8.9	80.0	.585				8
8.9	80.1	.595				9
8.9	80.2	.605				10
8.9	80.5	.615				11
						12





8.9	80.7	.625	13
8.9	80.8	.635	14
8.9	80.9	.645	15
8.9	81.1	.655	16
8.9	81.3	.665	17
8.9	81.3	.675	18
8.9	81.4	.685	19
8.9	81.5	.696	20
8.9	81.6	.706	21
8.9	81.6	.716	22
8.9	81.5	.726	23
8.9	81.6	.736	24
8.9	81.7	.746	25
8.9	81.6	.756	26
8.9	81.6	.766	27
8.9	81.7	.776	28
8.9	81.7	.786	29
8.9	81.7	.796	30
8.9	81.7	.806	31
8.9	81.8	.817	32
8.9	81.9	.827	33
8.9	81.9	.837	34
8.9	81.9	.847	35
8.9	82.0	.857	36
8.9	81.7	.867	37
8.9	81.5	.877	38



8.9	83.2	.887			39
8.9	82.4	.897			40
8.9	80.3	.907			41
8.9	80.7	.917			42
8.9	81.3	.927			43
8.9	82.5	.937			44
8.9	82.9	.948			45
8.9	82.6	.958			46
8.9	82.6	.968			47
8.9	82.9	.978			48
8.9	84.0	.988			49
8.9	83.7	.998			50
8.9	84.1	1.008			N
HEAD (FT)	OBS. WELL NO.	X	Y		
	CONC. (MG/L)	TIME (YEARS)			
	4	8	9		
.0	.0	.000			0
7.6	.9	.514			1
7.6	1.0	.524			2
7.6	1.0	.534			3
7.6	1.0	.544			4
7.6	1.0	.554			5
7.6	1.0	.565			6
7.6	1.1	.575			7
7.6	1.1	.585			8
7.6	1.1	.595			9
					10



7.6	1.1	.605	11
7.6	1.1	.615	12
7.6	1.1	.625	13
7.6	1.1	.635	14
7.6	1.1	.645	15
7.6	1.1	.655	16
7.6	1.2	.665	17
7.6	1.2	.675	18
7.6	1.2	.685	19
7.6	1.2	.696	20
7.6	1.1	.706	21
7.6	1.2	.716	22
7.6	1.2	.726	23
7.6	1.2	.736	24
7.6	1.2	.746	25
7.6	1.2	.756	26
7.6	1.2	.766	27
7.6	1.2	.776	28
7.6	1.2	.786	29
7.6	1.2	.796	30
7.6	1.2	.806	31
7.6	1.2	.817	32
7.6	1.2	.827	33
7.6	1.2	.837	34
7.6	1.2	.847	35
7.6	1.2	.857	36



7.6	1.2	.867	37
7.6	1.2	.877	38
7.6	1.2	.887	39
7.6	1.2	.897	40
7.6	1.2	.907	41
7.6	1.2	.917	42
7.6	1.2	.927	43
7.6	1.2	.937	44
7.6	1.2	.948	45
7.6	1.2	.958	46
7.6	1.2	.968	47
7.6	1.2	.978	48
7.6	1.2	.988	49
7.6	1.2	.998	50
7.6	1.3	1.008	

## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .34993E+08  
 CHEM.TIME(DAYS) = .40501E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .11089E+01  
 NO. MOVES COMPLETED = 110

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	2	2	4	28	95	3	0	0
0	0	5	22	46	89	93	7	1	0
0	0	11	68	79	86	78	8	1	0
0	0	7	55	84	82	43	8	1	0
0	0	2	33	75	75	29	7	1	0
0	0	0	5	68	66	26	7	1	0
0	0	0	0	0	0	0	0	0	0

## CHANGE IN CONCENTRATION





```

NUMBER OF TIME STEPS =      1
      DELTA T          =    .15779E+09
      TIME(SECONDS)    =    .15779E+09
      CHEM.TIME(SECONDS) =   .34993E+08
      CHEM.TIME(DAYS)   =   .40501E+03
      TIME(YEARS)       =   .50000E+01
      CHEM.TIME(YEARS)  =   .11089E+01
      NO. MOVES COMPLETED = 110

```

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	2	0	0	0
0	0	1	1	3	28	94	3	0	0
0	0	5	21	45	89	92	6	0	0
0	0	11	68	79	85	78	8	0	0
0	0	7	54	84	82	42	8	1	0
0	0	1	33	74	75	28	7	1	0
0	0	0	4	68	65	25	6	1	0
0	0	0	0	0	0	0	0	0	0

#### CONCENTRATION

```

NUMBER OF TIME STEPS =      1
      DELTA T          =    .15779E+09
      TIME(SECONDS)    =    .15779E+09
      CHEM.TIME(SECONDS) =   .38174E+08
      CHEM.TIME(DAYS)   =   .44183E+03
      TIME(YEARS)       =   .50000E+01
      CHEM.TIME(YEARS)  =   .12097E+01
      NO. MOVES COMPLETED = 120

```

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	2	2	3	29	95	9	0	0
0	0	5	18	46	90	93	7	0	0
0	0	10	69	82	88	83	8	1	0
0	0	13	63	82	78	58	7	1	0
0	0	2	43	79	82	18	8	1	0
0	0	0	5	70	68	26	7	1	0
0	0	0	0	0	0	0	0	0	0

#### CHANGE IN CONCENTRATION

```

NUMBER OF TIME STEPS =      1
      DELTA T          =    .15779E+09
      TIME(SECONDS)    =    .15779E+09
      CHEM.TIME(SECONDS) =   .38174E+08
      CHEM.TIME(DAYS)   =   .44183E+03
      TIME(YEARS)       =   .50000E+01

```



CHEM.TIME(YEARS) = .12097E+01  
 NO. MOVES COMPLETED = 120

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	2	0	0	0
0	0	2	1	3	29	94	9	0	0
0	0	4	17	46	89	92	7	0	0
0	0	10	68	82	88	82	8	0	0
0	0	12	63	82	78	57	7	1	0
0	0	2	42	79	82	17	7	1	0
0	0	0	5	70	67	25	7	1	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .41356E+08  
 CHEM.TIME(DAYS) = .47865E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .13105E+01  
 NO. MOVES COMPLETED = 130

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	2	2	3	30	95	3	0	0
0	0	6	29	47	90	93	14	0	0
0	0	16	72	84	89	88	9	1	0
0	0	10	73	82	83	51	7	1	0
0	0	3	57	78	78	14	6	1	0
0	0	0	6	71	71	23	7	1	0
0	0	0	0	0	0	0	0	0	0

## CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .41356E+08  
 CHEM.TIME(DAYS) = .47865E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .13105E+01  
 NO. MOVES COMPLETED = 130

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	2	0	0	0







## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .47718E+08  
 CHEM.TIME(DAYS) = .55229E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .15121E+01  
 NO. MOVES COMPLETED = 150

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	2	2	4	29	95	3	0	0
0	0	8	30	47	90	93	15	0	0
0	0	27	78	85	90	88	9	1	0
0	0	17	78	82	84	45	7	1	0
0	0	12	60	76	81	15	7	1	0
0	0	1	7	76	72	18	7	1	0
0	0	0	0	0	0	0	0	0	0

HEAD (FT)	CONC. (MG/L)	OBS.WELL NO. TIME (YEARS)	X 1	Y 3	N 4
.0	.0	.000			0
23.7	.0	1.018			1
23.7	.0	1.028			2
23.7	.0	1.038			3
23.7	.0	1.048			4
23.7	.0	1.058			5
23.7	.0	1.069			6
23.7	.0	1.079			7
23.7	.0	1.089			8
23.7	.0	1.099			9
23.7	.0	1.109			10





			11
23.7	.0	1.119	12
23.7	.0	1.129	13
23.7	.0	1.139	14
23.7	.0	1.149	15
23.7	.0	1.159	16
23.7	.0	1.169	17
23.7	.0	1.179	18
23.7	.0	1.190	19
23.7	.0	1.200	20
23.7	.0	1.210	21
23.7	.0	1.220	22
23.7	.0	1.230	23
23.7	.0	1.240	24
23.7	.0	1.250	25
23.7	.0	1.260	26
23.7	.0	1.270	27
23.7	.0	1.280	28
23.7	.0	1.290	29
23.7	.0	1.300	30
23.7	.0	1.310	31
23.7	.0	1.321	32
23.7	.0	1.331	33
23.7	.0	1.341	34
23.7	.0	1.351	35
23.7	.0	1.361	36
23.7	.0	1.371	



				37
23.7	.0	1.381		38
23.7	.0	1.391		39
23.7	.0	1.401		40
23.7	.0	1.411		41
23.7	.0	1.421		42
23.7	.0	1.431		43
23.7	.0	1.442		44
23.7	.0	1.452		45
23.7	.0	1.462		46
23.7	.0	1.472		47
23.7	.0	1.482		48
23.7	.0	1.492		49
23.7	.0	1.502		50
23.7	.0	1.512		N
HEAD (FT)	CONC. (MG/L)	OBS.WELL NO. TIME (YEARS)	X Y	
		2 2 7		
.0	.0	.000		0
-4.1	7.8	1.018		1
-4.1	8.1	1.028		2
-4.1	8.2	1.038		3
-4.1	9.4	1.048		4
-4.1	9.2	1.058		5
-4.1	8.4	1.069		6
-4.1	8.5	1.079		7
-4.1	8.6	1.089		8



			9
-4.1	10.9	1.099	10
-4.1	11.0	1.109	11
-4.1	11.6	1.119	12
-4.1	12.2	1.129	13
-4.1	12.3	1.139	14
-4.1	12.8	1.149	15
-4.1	12.9	1.159	16
-4.1	13.0	1.169	17
-4.1	13.0	1.179	18
-4.1	10.1	1.190	19
-4.1	10.2	1.200	20
-4.1	10.3	1.210	21
-4.1	10.5	1.220	22
-4.1	10.6	1.230	23
-4.1	10.7	1.240	24
-4.1	10.8	1.250	25
-4.1	10.6	1.260	26
-4.1	10.7	1.270	27
-4.1	10.9	1.280	28
-4.1	11.0	1.290	29
-4.1	15.8	1.300	30
-4.1	15.8	1.310	31
-4.1	15.9	1.321	32
-4.1	19.6	1.331	33
-4.1	19.6	1.341	34
-4.1	19.6	1.351	



-4.1	19.7	1.361				35
-4.1	19.7	1.371				36
-4.1	19.8	1.381				37
-4.1	22.6	1.391				38
-4.1	22.6	1.401				39
-4.1	22.7	1.411				40
-4.1	19.4	1.421				41
-4.1	19.5	1.431				42
-4.1	19.6	1.442				43
-4.1	26.9	1.452				44
-4.1	26.9	1.462				45
-4.1	27.4	1.472				46
-4.1	27.4	1.482				47
-4.1	33.4	1.492				48
-4.1	33.4	1.502				49
-4.1	26.6	1.512				50
			OBS.	WELL NO.	X	Y
HEAD (FT)	CONC. (MG/L)	TIME (YEARS)				N
			3	5	8	
.0	.0	.000				0
8.9	84.0	1.018				1
8.9	83.8	1.028				2
8.9	85.0	1.038				3
8.9	85.7	1.048				4
8.9	86.4	1.058				5
8.9	86.5	1.069				6





			7
8.9	86.5	1.079	8
8.9	85.0	1.089	9
8.9	83.9	1.099	10
8.9	82.3	1.109	11
8.9	82.2	1.119	12
8.9	81.3	1.129	13
8.9	80.5	1.139	14
8.9	80.2	1.149	15
8.9	79.6	1.159	16
8.9	79.0	1.169	17
8.9	79.1	1.179	18
8.9	78.6	1.190	19
8.9	78.8	1.200	20
8.9	78.4	1.210	21
8.9	79.5	1.220	22
8.9	80.1	1.230	23
8.9	80.6	1.240	24
8.9	80.8	1.250	25
8.9	81.4	1.260	26
8.9	81.9	1.270	27
8.9	82.3	1.280	28
8.9	83.0	1.290	29
8.9	83.2	1.300	30
8.9	83.5	1.310	31
8.9	83.9	1.321	32
8.9	83.9	1.331	



8.9	84.0	1.341			33
8.9	83.9	1.351			34
8.9	84.0	1.361			35
8.9	83.9	1.371			36
8.9	83.8	1.381			37
8.9	83.7	1.391			38
8.9	83.6	1.401			39
8.9	83.5	1.411			40
8.9	83.5	1.421			41
8.9	83.5	1.431			42
8.9	83.5	1.442			43
8.9	83.5	1.452			44
8.9	83.5	1.462			45
8.9	83.6	1.472			46
8.9	83.7	1.482			47
8.9	83.7	1.492			48
8.9	83.8	1.502			49
8.9	83.8	1.512			50
	OBS.	WELL NO.	X	Y	N
HEAD (FT)	CONC. (MG/L)	TIME (YEARS)			
	4	8	9		
					0
.0	.0	.000			1
7.6	1.3	1.018			2
7.6	1.3	1.028			3
7.6	1.3	1.038			4
7.6	1.3	1.048			



			5
7.6	1.3	1.058	
			6
7.6	1.3	1.069	
			7
7.6	1.3	1.079	
			8
7.6	1.3	1.089	
			9
7.6	1.3	1.099	
			10
7.6	1.4	1.109	
			11
7.6	1.4	1.119	
			12
7.6	1.4	1.129	
			13
7.6	1.4	1.139	
			14
7.6	1.4	1.149	
			15
7.6	1.3	1.159	
			16
7.6	1.4	1.169	
			17
7.6	1.3	1.179	
			18
7.6	1.4	1.190	
			19
7.6	1.4	1.200	
			20
7.6	1.4	1.210	
			21
7.6	1.4	1.220	
			22
7.6	1.4	1.230	
			23
7.6	1.3	1.240	
			24
7.6	1.3	1.250	
			25
7.6	1.3	1.260	
			26
7.6	1.3	1.270	
			27
7.6	1.3	1.280	
			28
7.6	1.3	1.290	
			29
7.6	1.3	1.300	
			30
7.6	1.3	1.310	



7.6	1.3	1.321	31
7.6	1.3	1.331	32
7.6	1.3	1.341	33
7.6	1.2	1.351	34
7.6	1.3	1.361	35
7.6	1.3	1.371	36
7.6	1.3	1.381	37
7.6	1.3	1.391	38
7.6	1.3	1.401	39
7.6	1.3	1.411	40
7.6	1.3	1.421	41
7.6	1.3	1.431	42
7.6	1.3	1.442	43
7.6	1.3	1.452	44
7.6	1.3	1.462	45
7.6	1.3	1.472	46
7.6	1.3	1.482	47
7.6	1.2	1.492	48
7.6	1.2	1.502	49
7.6	1.3	1.512	50

CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .50899E+08  
 CHEM.TIME(DAYS) = .58911E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .16129E+01  
 NO. MOVES COMPLETED = 160

0 0 0 0 0 0 0 0 0 0





0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	2	4	28	95	3	0	0
0	0	7	26	47	90	93	7	0	0
0	0	32	79	85	90	88	9	1	0
0	0	23	76	82	84	45	7	1	0
0	0	6	72	79	81	15	7	1	0
0	0	1	14	77	75	18	7	1	0
0	0	0	0	0	0	0	0	0	0

## CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .50899E+08  
 CHEM.TIME(DAYS) = .58911E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .16129E+01  
 NO. MOVES COMPLETED = 160

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	2	0	0	0
0	0	2	2	3	28	94	3	0	0
0	0	6	26	47	90	93	6	0	0
0	0	31	78	85	89	87	8	0	0
0	0	22	76	81	83	45	7	0	0
0	0	6	72	79	81	15	7	1	0
0	0	0	14	76	74	17	7	1	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .54080E+08  
 CHEM.TIME(DAYS) = .62593E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .17137E+01  
 NO. MOVES COMPLETED = 170

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	2	4	28	95	3	0	0
0	0	7	31	47	90	93	13	0	0
0	0	18	79	85	90	88	9	1	0
0	0	33	77	82	84	52	7	1	0



0	0	6	70	78	81	15	7	1	0
0	0	1	22	78	76	18	7	1	0
0	0	0	0	0	0	0	0	0	0

CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .54080E+08  
 CHEM.TIME(DAYS) = .62593E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .17137E+01  
 NO. MOVES COMPLETED = 170

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	2	0	0	0
0	0	2	2	3	28	94	2	0	0
0	0	7	30	47	89	93	12	0	0
0	0	17	78	85	90	87	9	0	0
0	0	33	77	81	83	51	7	1	0
0	0	6	70	78	81	14	7	1	0
0	0	0	21	78	75	18	7	1	0
0	0	0	0	0	0	0	0	0	0

CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .57262E+08  
 CHEM.TIME(DAYS) = .66275E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .18145E+01  
 NO. MOVES COMPLETED = 180

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	5	1	0	0
0	0	2	2	4	38	80	3	0	0
0	0	9	22	40	80	84	16	0	0
0	0	24	76	86	89	60	13	1	0
0	0	39	78	85	84	57	7	1	0
0	0	7	71	79	70	27	9	1	0
0	0	1	22	78	77	18	6	1	0
0	0	0	0	0	0	0	0	0	0

CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09



```

CHEM.TIME(SECONDS) = .57262E+08
CHEM.TIME(DAYS) = .66275E+03
      TIME(YEARS) = .50000E+01
CHEM.TIME(YEARS) = .18145E+01
NO. MOVES COMPLETED = 180

```

0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	5	0	0
0	0	1	2	3	37	80	2	0
0	0	8	21	39	79	83	15	0
0	0	24	76	85	89	60	13	0
0	0	38	78	84	83	56	7	1
0	0	7	71	79	70	27	8	1
0	0	0	22	78	76	17	6	1
0	0	0	0	0	0	0	0	0

## CONCENTRATION

```

NUMBER OF TIME STEPS =      1
      DELTA T          =    .15779E+09
      TIME(SECONDS)    =    .15779E+09
CHEM.TIME(SECONDS)    =    .60443E+08
CHEM.TIME(DAYS)       =    .69957E+03
      TIME(YEARS)      =    .50000E+01
CHEM.TIME(YEARS)      =    .19153E+01
NO. MOVES COMPLETED =    190

```

[illegible]

### CHANGE IN CONCENTRATION

```

NUMBER OF TIME STEPS =      1
      DELTA T          =    .15779E+09
      TIME(SECONDS)    =    .15779E+09
CHEM.TIME(SECONDS)    =    .60443E+08
CHEM.TIME(DAYS)       =    .69957E+03
      TIME(YEARS)      =    .50000E+01
CHEM.TIME(YEARS)      =    .19153E+01
NO. MOVES COMPLETED =    190

```

[illegible]



0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	3	0	0	0
0	0	2	1	3	33	94	3	0	0
0	0	9	28	41	87	91	6	0	0
0	0	39	75	79	81	80	8	0	0
0	0	32	80	87	86	46	9	1	0
0	0	16	73	80	74	38	6	1	0
0	0	0	28	78	71	21	7	1	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .63624E+08  
 CHEM.TIME(DAYS) = .73639E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .20161E+01  
 NO. MOVES COMPLETED = 200

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	2	2	4	37	95	3	0	0
0	0	10	32	36	90	93	16	0	0
0	0	44	77	81	88	75	9	1	0
0	0	38	80	86	80	52	7	1	0
0	0	23	75	83	79	17	8	1	0
0	0	1	29	79	70	31	7	1	0
0	0	0	0	0	0	0	0	0	0

HEAD (FT)	CONC. (MG/L)	OBS.WELL NO.	X	Y	N
-----------	--------------	--------------	---	---	---

1	3	4
---	---	---

.0	.0	.000	0
23.7	.1	1.522	1
23.7	.0	1.532	2
23.7	.0	1.542	3
23.7	.0	1.552	4
23.7	.0	1.562	5
23.7	.0	1.573	6
			7





23.7	.0	1.583	8
23.7	.0	1.593	9
23.7	.0	1.603	10
23.7	.0	1.613	11
23.7	.0	1.623	12
23.7	.0	1.633	13
23.7	.0	1.643	14
23.7	.0	1.653	15
23.7	.0	1.663	16
23.7	.0	1.673	17
23.7	.0	1.683	18
23.7	.0	1.694	19
23.7	.0	1.704	20
23.7	.0	1.714	21
23.7	.1	1.724	22
23.7	.1	1.734	23
23.7	.1	1.744	24
23.7	.1	1.754	25
23.7	.1	1.764	26
23.7	.1	1.774	27
23.7	.0	1.784	28
23.7	.0	1.794	29
23.7	.0	1.804	30
23.7	.0	1.815	31
23.7	.0	1.825	32
23.7	.0	1.835	33



23.7	.0	1.845				34
23.7	.0	1.855				35
23.7	.0	1.865				36
23.7	.0	1.875				37
23.7	.0	1.885				38
23.7	.0	1.895				39
23.7	.0	1.905				40
23.7	.0	1.915				41
23.7	.0	1.925				42
23.7	.0	1.935				43
23.7	.0	1.946				44
23.7	.0	1.956				45
23.7	.0	1.966				46
23.7	.0	1.976				47
23.7	.0	1.986				48
23.7	.0	1.996				49
23.7	.0	2.006				50
23.7	.0	2.016				
		OBS.WELL NO.	X	Y		N
HEAD (FT)	CONC. (MG/L)	TIME (YEARS)				
		2	2	7		
.0	.0	.000				0
-4.1	26.7	1.522				1
-4.1	26.7	1.532				2
-4.1	24.4	1.542				3
-4.1	29.7	1.552				4
						5



-4.1	31.4	1.562	6
-4.1	31.4	1.573	7
-4.1	34.2	1.583	8
-4.1	31.7	1.593	9
-4.1	31.6	1.603	10
-4.1	31.6	1.613	11
-4.1	25.2	1.623	12
-4.1	25.2	1.633	13
-4.1	24.6	1.643	14
-4.1	24.7	1.653	15
-4.1	25.5	1.663	16
-4.1	25.5	1.673	17
-4.1	17.1	1.683	18
-4.1	17.3	1.694	19
-4.1	17.4	1.704	20
-4.1	17.6	1.714	21
-4.1	17.7	1.724	22
-4.1	17.9	1.734	23
-4.1	18.1	1.744	24
-4.1	18.2	1.754	25
-4.1	18.4	1.764	26
-4.1	20.6	1.774	27
-4.1	23.5	1.784	28
-4.1	23.6	1.794	29
-4.1	24.3	1.804	30
-4.1	24.4	1.815	31



-4.1	24.6	1.825			32
-4.1	29.6	1.835			33
-4.1	29.7	1.845			34
-4.1	31.0	1.855			35
-4.1	31.1	1.865			36
-4.1	32.8	1.875			37
-4.1	35.0	1.885			38
-4.1	35.0	1.895			39
-4.1	40.5	1.905			40
-4.1	39.5	1.915			41
-4.1	34.8	1.925			42
-4.1	34.8	1.935			43
-4.1	34.8	1.946			44
-4.1	38.4	1.956			45
-4.1	38.3	1.966			46
-4.1	40.4	1.976			47
-4.1	43.0	1.986			48
-4.1	42.9	1.996			49
-4.1	44.1	2.006			50
-4.1	44.1	2.016			N
HEAD (FT)	CONC. (MG/L)	OBS.WELL NO.	X	Y	
		TIME (YEARS)			
		3	5	8	
.0	.0	.000			0
8.9	83.9	1.522			1
8.9	83.9	1.532			2
					3





8.9	84.0	1.542	4
8.9	84.0	1.552	5
8.9	83.9	1.562	6
8.9	83.9	1.573	7
8.9	83.9	1.583	8
8.9	83.9	1.593	9
8.9	83.8	1.603	10
8.9	83.8	1.613	11
8.9	83.8	1.623	12
8.9	83.8	1.633	13
8.9	83.8	1.643	14
8.9	83.7	1.653	15
8.9	83.7	1.663	16
8.9	83.7	1.673	17
8.9	83.8	1.683	18
8.9	83.8	1.694	19
8.9	83.8	1.704	20
8.9	83.9	1.714	21
8.9	83.8	1.724	22
8.9	83.8	1.734	23
8.9	85.3	1.744	24
8.9	84.0	1.754	25
8.9	81.7	1.764	26
8.9	82.2	1.774	27
8.9	82.9	1.784	28
8.9	84.3	1.794	29



8.9	84.3	1.804			30
8.9	83.9	1.815			31
8.9	83.6	1.825			32
8.9	83.9	1.835			33
8.9	85.0	1.845			34
8.9	84.8	1.855			35
8.9	84.9	1.865			36
8.9	84.7	1.875			37
8.9	84.6	1.885			38
8.9	85.7	1.895			39
8.9	86.3	1.905			40
8.9	86.9	1.915			41
8.9	87.0	1.925			42
8.9	87.0	1.935			43
8.9	85.3	1.946			44
8.9	84.2	1.956			45
8.9	82.6	1.966			46
8.9	82.5	1.976			47
8.9	81.5	1.986			48
8.9	80.7	1.996			49
8.9	80.4	2.006			50
8.9	79.8	2.016			
	OBS.WELL NO.	X	Y		N
HEAD (FT)	CONC. (MG/L)	TIME (YEARS)			
	4	8	9		
.0	.0	.000			0
					1



7.6	1.3	1.522	2
7.6	1.2	1.532	3
7.6	1.2	1.542	4
7.6	1.2	1.552	5
7.6	1.2	1.562	6
7.6	1.2	1.573	7
7.6	1.2	1.583	8
7.6	1.2	1.593	9
7.6	1.2	1.603	10
7.6	1.2	1.613	11
7.6	1.2	1.623	12
7.6	1.2	1.633	13
7.6	1.2	1.643	14
7.6	1.2	1.653	15
7.6	1.2	1.663	16
7.6	1.2	1.673	17
7.6	1.2	1.683	18
7.6	1.2	1.694	19
7.6	1.2	1.704	20
7.6	1.2	1.714	21
7.6	1.2	1.724	22
7.6	1.2	1.734	23
7.6	1.2	1.744	24
7.6	1.2	1.754	25
7.6	1.2	1.764	26
7.6	1.2	1.774	27



7.6	1.2	1.784	28
7.6	1.2	1.794	29
7.6	1.3	1.804	30
7.6	1.2	1.815	31
7.6	1.3	1.825	32
7.6	1.2	1.835	33
7.6	1.2	1.845	34
7.6	1.2	1.855	35
7.6	1.3	1.865	36
7.6	1.3	1.875	37
7.6	1.3	1.885	38
7.6	1.3	1.895	39
7.6	1.3	1.905	40
7.6	1.3	1.915	41
7.6	1.3	1.925	42
7.6	1.3	1.935	43
7.6	1.3	1.946	44
7.6	1.3	1.956	45
7.6	1.4	1.966	46
7.6	1.4	1.976	47
7.6	1.4	1.986	48
7.6	1.4	1.996	49
7.6	1.4	2.006	50
7.6	1.4	2.016	
CONCENTRATION			

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09





```

CHEM.TIME(SECONDS) = .66805E+08
CHEM.TIME(DAYS) = .77321E+03
      TIME(YEARS) = .50000E+01
CHEM.TIME(YEARS) = .21169E+01
NO. MOVES COMPLETED = 210

```

[illegible]

### CHANGE IN CONCENTRATION

```

NUMBER OF TIME STEPS =      1
      DELTA T          =    .15779E+09
      TIME(SECONDS)    =    .15779E+09
CHEM.TIME(SECONDS)    =    .66805E+08
CHEM.TIME(DAYS)       =    .77321E+03
      TIME(YEARS)      =    .50000E+01
CHEM.TIME(YEARS)      =    .21169E+01
NO. MOVES COMPLETED =    210

```

[illegible]

## CONCENTRATION

```

NUMBER OF TIME STEPS =      1
      DELTA T          =    .15779E+09
      TIME(SECONDS)    =    .15779E+09
CHEM.TIME(SECONDS)    =    .69986E+08
CHEM.TIME(DAYS)       =    .81003E+03
      TIME(YEARS)      =    .50000E+01
CHEM.TIME(YEARS)      =    .22177E+01
NO. MOVES COMPLETED =    220

```

[illegible]



0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	3	4	32	95	3	0	0
0	0	11	30	40	90	93	16	0	0
0	0	51	77	85	90	88	8	1	0
0	0	38	82	85	84	60	8	1	0
0	0	27	77	82	79	13	7	1	0
0	0	1	30	80	73	21	7	2	0
0	0	0	0	0	0	0	0	0	0

## CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .69986E+08  
 CHEM.TIME(DAYS) = .81003E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .22177E+01  
 NO. MOVES COMPLETED = 220

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	3	0	0	0
0	0	2	2	3	32	94	2	0	0
0	0	10	29	40	90	93	15	0	0
0	0	50	77	84	89	88	8	0	0
0	0	38	82	85	84	59	7	1	0
0	0	26	76	81	78	13	6	1	0
0	0	0	29	79	73	21	6	1	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .73168E+08  
 CHEM.TIME(DAYS) = .84685E+03  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .23185E+01  
 NO. MOVES COMPLETED = 230

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	2	4	37	95	3	0	0
0	0	10	36	36	90	94	7	0	0
0	0	58	79	85	90	88	9	1	0
0	0	40	82	85	84	51	8	1	0
0	0	30	76	78	80	15	7	1	0
0	0	4	30	80	73	19	7	1	0



0 0 0 0 0 0 0 0 0 0  
CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
DELTA T = .15779E+09  
TIME(SECONDS) = .15779E+09  
CHEM.TIME(SECONDS) = .73168E+08  
CHEM.TIME(DAYS) = .84685E+03  
TIME(YEARS) = .50000E+01  
CHEM.TIME(YEARS) = .23185E+01  
NO. MOVES COMPLETED = 230

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	2	0	0	0
0	0	2	2	3	37	94	3	0	0
0	0	9	36	36	90	93	6	0	0
0	0	58	78	85	89	87	8	0	0
0	0	40	82	84	83	51	7	0	0
0	0	29	76	78	80	14	7	1	0
0	0	3	30	79	72	18	6	1	0
0	0	0	0	0	0	0	0	0	0

CONCENTRATION

NUMBER OF TIME STEPS = 1  
DELTA T = .15779E+09  
TIME(SECONDS) = .15779E+09  
CHEM.TIME(SECONDS) = .76349E+08  
CHEM.TIME(DAYS) = .88367E+03  
TIME(YEARS) = .50000E+01  
CHEM.TIME(YEARS) = .24193E+01  
NO. MOVES COMPLETED = 240

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	2	4	31	95	9	0	0
0	0	11	30	45	90	93	7	0	0
0	0	47	79	86	90	88	8	1	0
0	0	50	81	85	84	48	7	1	0
0	0	35	78	79	81	15	7	1	0
0	0	4	36	77	75	18	7	1	0
0	0	0	0	0	0	0	0	0	0

CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
DELTA T = .15779E+09  
TIME(SECONDS) = .15779E+09  
CHEM.TIME(SECONDS) = .76349E+08  
CHEM.TIME(DAYS) = .88367E+03



TIME (YEARS) = .50000E+01  
 CHEM.TIME (YEARS) = .24193E+01  
 NO. MOVES COMPLETED = 240

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	3	0	0	0
0	0	3	2	3	30	94	9	0	0
0	0	11	29	45	89	93	6	0	0
0	0	47	79	85	90	87	8	0	0
0	0	50	80	84	84	48	7	1	0
0	0	35	78	79	81	15	7	1	0
0	0	3	35	77	74	17	6	1	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME (SECONDS) = .15779E+09  
 CHEM.TIME (SECONDS) = .79530E+08  
 CHEM.TIME (DAYS) = .92049E+03  
 TIME (YEARS) = .50000E+01  
 CHEM.TIME (YEARS) = .25202E+01  
 NO. MOVES COMPLETED = 250

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	2	4	34	95	3	0	0
0	0	17	33	38	90	93	15	0	0
0	0	48	79	86	90	88	8	1	0
0	0	52	82	84	84	51	8	1	0
0	0	34	80	79	82	16	7	1	0
0	0	4	36	79	76	18	7	1	0
0	0	0	0	0	0	0	0	0	0

HEAD (FT)	CONC. (MG/L)	OBS.WELL NO.	X	Y	N
		TIME (YEARS)			
		1	3	4	
.0	.0	.000			0
23.7	.0	2.026			1
23.7	.0	2.036			2
23.7	.0	2.046			3





			4
23.7	.0	2.056	5
23.7	.0	2.067	6
23.7	.0	2.077	7
23.7	.0	2.087	8
23.7	.0	2.097	9
23.7	.0	2.107	10
23.7	.0	2.117	11
23.7	.0	2.127	12
23.7	.0	2.137	13
23.7	.0	2.147	14
23.7	.0	2.157	15
23.7	.0	2.167	16
23.7	.0	2.177	17
23.7	.0	2.187	18
23.7	.0	2.198	19
23.7	.0	2.208	20
23.7	.1	2.218	21
23.7	.0	2.228	22
23.7	.0	2.238	23
23.7	.0	2.248	24
23.7	.0	2.258	25
23.7	.0	2.268	26
23.7	.0	2.278	27
23.7	.0	2.288	28
23.7	.0	2.298	29
23.7	.0	2.308	



					30
23.7	.0	2.319			31
23.7	.0	2.329			32
23.7	.0	2.339			33
23.7	.0	2.349			34
23.7	.0	2.359			35
23.7	.1	2.369			36
23.7	.1	2.379			37
23.7	.1	2.389			38
23.7	.0	2.399			39
23.7	.0	2.409			40
23.7	.1	2.419			41
23.7	.1	2.429			42
23.7	.0	2.440			43
23.7	.0	2.450			44
23.7	.0	2.460			45
23.7	.1	2.470			46
23.7	.1	2.480			47
23.7	.0	2.490			48
23.7	.0	2.500			49
23.7	.0	2.510			50
23.7	.0	2.520			
		OBS.WELL NO.	X	Y	N
HEAD (FT)	CONC. (MG/L)	TIME (YEARS)			
		2	2	7	
					0
.0	.0	.000			1
-4.1	44.0	2.026			



			2
-4.1	43.9	2.036	3
-4.1	39.6	2.046	4
-4.1	39.6	2.056	5
-4.1	39.6	2.067	6
-4.1	39.6	2.077	7
-4.1	39.6	2.087	8
-4.1	39.5	2.097	9
-4.1	44.8	2.107	10
-4.1	43.5	2.117	11
-4.1	43.4	2.127	12
-4.1	43.4	2.137	13
-4.1	43.3	2.147	14
-4.1	46.7	2.157	15
-4.1	46.6	2.167	16
-4.1	46.6	2.177	17
-4.1	51.1	2.187	18
-4.1	51.0	2.198	19
-4.1	50.8	2.208	20
-4.1	50.7	2.218	21
-4.1	50.6	2.228	22
-4.1	50.4	2.238	23
-4.1	55.5	2.248	24
-4.1	55.4	2.258	25
-4.1	55.2	2.268	26
-4.1	52.2	2.278	27
-4.1	52.0	2.288	



				28
-4.1	55.7	2.298		29
-4.1	58.3	2.308		30
-4.1	58.1	2.319		31
-4.1	56.1	2.329		32
-4.1	56.0	2.339		33
-4.1	58.7	2.349		34
-4.1	58.5	2.359		35
-4.1	43.8	2.369		36
-4.1	43.8	2.379		37
-4.1	43.8	2.389		38
-4.1	40.3	2.399		39
-4.1	44.3	2.409		40
-4.1	47.3	2.419		41
-4.1	47.3	2.429		42
-4.1	49.3	2.440		43
-4.1	51.8	2.450		44
-4.1	51.7	2.460		45
-4.1	51.6	2.470		46
-4.1	48.1	2.480		47
-4.1	48.0	2.490		48
-4.1	51.2	2.500		49
-4.1	51.1	2.510		50
-4.1	47.5	2.520		
	OBS.WELL NO.	X	Y	N
HEAD (FT)	CONC. (MG/L)	TIME (YEARS)		
	3	5	8	





			0
.0	.0	.000	1
8.9	79.2	2.026	2
8.9	79.3	2.036	3
8.9	78.8	2.046	4
8.9	78.9	2.056	5
8.9	78.6	2.067	6
8.9	79.6	2.077	7
8.9	80.3	2.087	8
8.9	80.8	2.097	9
8.9	80.9	2.107	10
8.9	81.6	2.117	11
8.9	82.0	2.127	12
8.9	82.5	2.137	13
8.9	83.2	2.147	14
8.9	83.4	2.157	15
8.9	83.6	2.167	16
8.9	84.0	2.177	17
8.9	84.1	2.187	18
8.9	84.1	2.198	19
8.9	84.1	2.208	20
8.9	84.2	2.218	21
8.9	84.1	2.228	22
8.9	84.0	2.238	23
8.9	83.8	2.248	24
8.9	83.7	2.258	25
8.9	83.7	2.268	



8.9	83.7	2.278	26
8.9	83.6	2.288	27
8.9	83.6	2.298	28
8.9	83.6	2.308	29
8.9	83.6	2.319	30
8.9	83.7	2.329	31
8.9	83.8	2.339	32
8.9	83.9	2.349	33
8.9	83.9	2.359	34
8.9	84.0	2.369	35
8.9	84.0	2.379	36
8.9	84.1	2.389	37
8.9	84.1	2.399	38
8.9	84.1	2.409	39
8.9	84.1	2.419	40
8.9	84.1	2.429	41
8.9	84.0	2.440	42
8.9	84.0	2.450	43
8.9	84.0	2.460	44
8.9	83.9	2.470	45
8.9	83.9	2.480	46
8.9	83.9	2.490	47
8.9	83.9	2.500	48
8.9	83.9	2.510	49
8.9	83.8	2.520	50

	OBS.	WELL NO.	X	Y	N
HEAD (FT)	CONC. (MG/L)	TIME (YEARS)			



4                      8                      9

			0
.0	.0	.000	1
7.6	1.4	2.026	2
7.6	1.3	2.036	3
7.6	1.4	2.046	4
7.6	1.4	2.056	5
7.6	1.4	2.067	6
7.6	1.4	2.077	7
7.6	1.4	2.087	8
7.6	1.3	2.097	9
7.6	1.3	2.107	10
7.6	1.3	2.117	11
7.6	1.3	2.127	12
7.6	1.3	2.137	13
7.6	1.3	2.147	14
7.6	1.3	2.157	15
7.6	1.3	2.167	16
7.6	1.3	2.177	17
7.6	1.3	2.187	18
7.6	1.3	2.198	19
7.6	1.2	2.208	20
7.6	1.3	2.218	21
7.6	1.3	2.228	22
7.6	1.3	2.238	23
7.6	1.3	2.248	



			24
7.6	1.3	2.258	25
7.6	1.3	2.268	26
7.6	1.3	2.278	27
7.6	1.3	2.288	28
7.6	1.3	2.298	29
7.6	1.3	2.308	30
7.6	1.3	2.319	31
7.6	1.3	2.329	32
7.6	1.3	2.339	33
7.6	1.2	2.349	34
7.6	1.2	2.359	35
7.6	1.3	2.369	36
7.6	1.3	2.379	37
7.6	1.2	2.389	38
7.6	1.2	2.399	39
7.6	1.2	2.409	40
7.6	1.2	2.419	41
7.6	1.2	2.429	42
7.6	1.2	2.440	43
7.6	1.2	2.450	44
7.6	1.2	2.460	45
7.6	1.2	2.470	46
7.6	1.2	2.480	47
7.6	1.2	2.490	48
7.6	1.2	2.500	49
7.6	1.2	2.510	





7.6                      1.2                      2.520  
CONCENTRATION

NUMBER OF TIME STEPS = 1  
DELTA T = .15779E+09  
TIME(SECONDS) = .15779E+09  
CHEM.TIME(SECONDS) = .82711E+08  
CHEM.TIME(DAYS) = .95731E+03  
TIME(YEARS) = .50000E+01  
CHEM.TIME(YEARS) = .26210E+01  
NO. MOVES COMPLETED = 260

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	4	0	0	0
0	0	2	2	5	44	87	3	0	0
0	0	16	26	53	82	85	8	0	0
0	0	42	79	86	90	88	13	1	0
0	0	56	82	85	81	64	9	1	0
0	0	31	79	79	81	27	7	1	0
0	0	4	42	79	77	17	7	1	0
0	0	0	0	0	0	0	0	0	0

CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
DELTA T = .15779E+09  
TIME(SECONDS) = .15779E+09  
CHEM.TIME(SECONDS) = .82711E+08  
CHEM.TIME(DAYS) = .95731E+03  
TIME(YEARS) = .50000E+01  
CHEM.TIME(YEARS) = .26210E+01  
NO. MOVES COMPLETED = 260

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	2	1	4	43	86	3	0	0
0	0	16	26	52	81	85	8	0	0
0	0	42	78	86	89	87	13	0	0
0	0	56	81	84	81	64	9	1	0
0	0	30	78	79	81	27	7	1	0
0	0	3	41	79	77	17	7	1	0
0	0	0	0	0	0	0	0	0	0

CONCENTRATION

NUMBER OF TIME STEPS = 1  
DELTA T = .15779E+09  
TIME(SECONDS) = .15779E+09  
CHEM.TIME(SECONDS) = .85892E+08



```

CHEM.TIME(DAYS)      = .99413E+03
      TIME(YEARS)     = .50000E+01
CHEM.TIME(YEARS)     = .27218E+01
NO. MOVES COMPLETED = 270

```

0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	2	3	0	0
0	0	2	2	4	30	93	3	0
0	0	16	27	53	84	87	25	1
0	0	51	79	82	83	68	10	1
0	0	55	82	87	85	51	12	1
0	0	37	79	81	76	39	8	1
0	0	4	42	79	71	17	7	1
0	0	0	0	0	0	0	0	0

### CHANGE IN CONCENTRATION

```

NUMBER OF TIME STEPS =      1
      DELTA T          =    .15779E+09
      TIME(SECONDS)    =    .15779E+09
CHEM.TIME(SECONDS)     =    .85892E+08
CHEM.TIME(DAYS)        =    .99413E+03
      TIME(YEARS)      =    .50000E+01
CHEM.TIME(YEARS)       =    .27218E+01
NO. MOVES COMPLETED   =    270

```

0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0
0	0	2	2	4	29	93	3	0
0	0	16	27	53	83	86	25	0
0	0	51	79	82	82	67	10	0
0	0	55	82	87	85	51	11	1
0	0	37	78	80	75	38	8	1
0	0	3	41	79	70	17	7	1
0	0	0	0	0	0	0	0	0

## CONCENTRATION

```

NUMBER OF TIME STEPS =      1
      DELTA T          =    .15779E+09
      TIME(SECONDS)    =    .15779E+09
CHEM.TIME(SECONDS)    =    .89074E+08
CHEM.TIME(DAYS)       =    .10309E+04
      TIME(YEARS)      =    .50000E+01
CHEM.TIME(YEARS)      =    .28226E+01
NO. MOVES COMPLETED =    280

```

[illegible]







## CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .92255E+08  
 CHEM.TIME(DAYS) = .10678E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .29234E+01  
 NO. MOVES COMPLETED = 290

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	2	0	0	0
0	0	2	1	3	29	94	9	0	0
0	0	10	20	46	89	92	7	0	0
0	0	57	77	82	88	82	8	0	0
0	0	60	84	85	78	57	7	1	0
0	0	43	79	82	83	17	7	1	0
0	0	3	46	79	71	26	7	1	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .95436E+08  
 CHEM.TIME(DAYS) = .11046E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .30242E+01  
 NO. MOVES COMPLETED = 300

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	2	3	30	95	3	0	0
0	0	15	32	47	90	93	14	0	0
0	0	62	76	84	89	88	9	1	0
0	0	60	84	86	84	51	7	1	0
0	0	39	80	82	78	14	6	1	0
0	0	4	47	80	73	23	7	2	0
0	0	0	0	0	0	0	0	0	0

HEAD (FT)	CONC. (MG/L)	OBS.WELL NO.	X	Y	N
		TIME (YEARS)			
		1	3	4	





.0	.0	.000	1
23.7	.1	2.530	2
23.7	.1	2.540	3
23.7	.0	2.550	4
23.7	.0	2.560	5
23.7	.0	2.571	6
23.7	.1	2.581	7
23.7	.1	2.591	8
23.7	.1	2.601	9
23.7	.1	2.611	10
23.7	.1	2.621	11
23.7	.1	2.631	12
23.7	.0	2.641	13
23.7	.0	2.651	14
23.7	.0	2.661	15
23.7	.0	2.671	16
23.7	.0	2.681	17
23.7	.0	2.692	18
23.7	.0	2.702	19
23.7	.0	2.712	20
23.7	.0	2.722	21
23.7	.0	2.732	22
23.7	.0	2.742	23
23.7	.0	2.752	24
23.7	.0	2.762	25
23.7	.0	2.772	26



23.7	.0	2.782	27
23.7	.0	2.792	28
23.7	.0	2.802	29
23.7	.0	2.812	30
23.7	.0	2.823	31
23.7	.0	2.833	32
23.7	.0	2.843	33
23.7	.0	2.853	34
23.7	.0	2.863	35
23.7	.0	2.873	36
23.7	.0	2.883	37
23.7	.0	2.893	38
23.7	.0	2.903	39
23.7	.0	2.913	40
23.7	.0	2.923	41
23.7	.0	2.933	42
23.7	.0	2.944	43
23.7	.0	2.954	44
23.7	.0	2.964	45
23.7	.0	2.974	46
23.7	.0	2.984	47
23.7	.0	2.994	48
23.7	.0	3.004	49
23.7	.0	3.014	50
23.7	.0	3.024	

	OBS.	WELL NO.	X	Y	N
HEAD (FT)	CONC. (MG/L)	TIME (YEARS)			



2                      2            7

.0	.0	.000	0
-4.1	47.5	2.530	1
-4.1	42.2	2.540	2
-4.1	42.2	2.550	3
-4.1	42.2	2.560	4
-4.1	42.3	2.571	5
-4.1	42.3	2.581	6
-4.1	42.3	2.591	7
-4.1	42.4	2.601	8
-4.1	42.4	2.611	9
-4.1	42.4	2.621	10
-4.1	44.4	2.631	11
-4.1	47.0	2.641	12
-4.1	47.0	2.651	13
-4.1	47.6	2.661	14
-4.1	47.6	2.671	15
-4.1	47.6	2.681	16
-4.1	50.6	2.692	17
-4.1	50.6	2.702	18
-4.1	51.5	2.712	19
-4.1	51.5	2.722	20
-4.1	52.7	2.732	21
-4.1	54.4	2.742	22
-4.1	54.3	2.752	23
			24



-4.1	57.8	2.762	25
-4.1	57.4	2.772	26
-4.1	55.1	2.782	27
-4.1	55.0	2.792	28
-4.1	54.9	2.802	29
-4.1	56.8	2.812	30
-4.1	56.7	2.823	31
-4.1	58.2	2.833	32
-4.1	60.2	2.843	33
-4.1	60.0	2.853	34
-4.1	60.7	2.863	35
-4.1	60.6	2.873	36
-4.1	60.4	2.883	37
-4.1	60.3	2.893	38
-4.1	57.9	2.903	39
-4.1	57.8	2.913	40
-4.1	57.7	2.923	41
-4.1	57.5	2.933	42
-4.1	57.4	2.944	43
-4.1	57.3	2.954	44
-4.1	61.7	2.964	45
-4.1	60.9	2.974	46
-4.1	60.8	2.984	47
-4.1	60.7	2.994	48
-4.1	60.5	3.004	49
-4.1	62.4	3.014	50





HEAD (FT)	CONC. (MG/L)	OBS. WELL NO.	TIME (YEARS)	X	Y	N
-4.1	62.2	3.024				
		3	5	8		
.0	.0	.000				0
8.9	83.9	2.530				1
8.9	83.9	2.540				2
8.9	83.9	2.550				3
8.9	84.0	2.560				4
8.9	84.0	2.571				5
8.9	83.9	2.581				6
8.9	83.9	2.591				7
8.9	85.2	2.601				8
8.9	83.6	2.611				9
8.9	81.2	2.621				10
8.9	81.8	2.631				11
8.9	82.5	2.641				12
8.9	83.8	2.651				13
8.9	83.7	2.661				14
8.9	83.8	2.671				15
8.9	83.5	2.681				16
8.9	83.8	2.692				17
8.9	84.8	2.702				18
8.9	84.6	2.712				19
8.9	85.1	2.722				20
8.9	84.8	2.732				21
						22



8.9	84.7	2.742	23
8.9	85.8	2.752	24
8.9	86.3	2.762	25
8.9	87.0	2.772	26
8.9	87.0	2.782	27
8.9	87.0	2.792	28
8.9	85.3	2.802	29
8.9	84.3	2.812	30
8.9	82.6	2.823	31
8.9	82.5	2.833	32
8.9	81.5	2.843	33
8.9	80.7	2.853	34
8.9	80.4	2.863	35
8.9	79.9	2.873	36
8.9	79.2	2.883	37
8.9	79.3	2.893	38
8.9	78.8	2.903	39
8.9	79.0	2.913	40
8.9	78.6	2.923	41
8.9	79.6	2.933	42
8.9	80.3	2.944	43
8.9	80.8	2.954	44
8.9	81.0	2.964	45
8.9	81.6	2.974	46
8.9	82.1	2.984	47
8.9	82.5	2.994	48



8.9	83.2	3.004				49
8.9	83.4	3.014				50
8.9	83.6	3.024				N
HEAD (FT)	CONC. (MG/L)	OBS.WELL NO.	X	Y		
		TIME (YEARS)				
		4	8	9		
.0	.0	.000				0
7.6	1.2	2.530				1
7.6	1.2	2.540				2
7.6	1.2	2.550				3
7.6	1.2	2.560				4
7.6	1.2	2.571				5
7.6	1.2	2.581				6
7.6	1.2	2.591				7
7.6	1.2	2.601				8
7.6	1.2	2.611				9
7.6	1.2	2.621				10
7.6	1.2	2.631				11
7.6	1.2	2.641				12
7.6	1.2	2.651				13
7.6	1.3	2.661				14
7.6	1.2	2.671				15
7.6	1.3	2.681				16
7.6	1.2	2.692				17
7.6	1.2	2.702				18
7.6	1.2	2.712				19
						20



7.6	1.3	2.722	21
7.6	1.3	2.732	22
7.6	1.3	2.742	23
7.6	1.3	2.752	24
7.6	1.3	2.762	25
7.6	1.3	2.772	26
7.6	1.3	2.782	27
7.6	1.3	2.792	28
7.6	1.3	2.802	29
7.6	1.3	2.812	30
7.6	1.4	2.823	31
7.6	1.4	2.833	32
7.6	1.4	2.843	33
7.6	1.4	2.853	34
7.6	1.4	2.863	35
7.6	1.4	2.873	36
7.6	1.4	2.883	37
7.6	1.3	2.893	38
7.6	1.4	2.903	39
7.6	1.4	2.913	40
7.6	1.4	2.923	41
7.6	1.4	2.933	42
7.6	1.4	2.944	43
7.6	1.3	2.954	44
7.6	1.3	2.964	45
7.6	1.3	2.974	46





7.6	1.3	2.984
7.6	1.3	2.994
7.6	1.3	3.004
7.6	1.3	3.014
7.6	1.3	3.024

47

48

49

50

## CONCENTRATION

```

NUMBER OF TIME STEPS =      1
      DELTA T          = .15779E+09
      TIME(SECONDS)    = .15779E+09
CHEM.TIME(SECONDS)    = .98617E+08
CHEM.TIME(DAYS)       = .11414E+04
      TIME(YEARS)      = .50000E+01
CHEM.TIME(YEARS)      = .31250E+01
NO. MOVES COMPLETED =    310

```

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	3	4	30	95	3	0	0
0	0	16	30	47	90	93	7	0	0
0	0	66	79	85	90	88	9	1	0
0	0	52	83	85	84	52	8	1	0
0	0	42	79	80	79	14	7	1	0
0	0	8	47	80	74	20	6	1	0
0	0	0	0	0	0	0	0	0	0

## CHANGE IN CONCENTRATION

```

NUMBER OF TIME STEPS =      1
      DELTA T          = .15779E+09
      TIME(SECONDS)    = .15779E+09
CHEM.TIME(SECONDS)    = .98617E+08
CHEM.TIME(DAYS)       = .11414E+04
      TIME(YEARS)      = .50000E+01
CHEM.TIME(YEARS)      = .31250E+01
NO. MOVES COMPLETED =    310

```

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	2	0	0	0
0	0	3	2	3	29	94	3	0	0
0	0	15	29	47	89	93	6	0	0
0	0	66	79	85	90	87	8	0	0
0	0	52	82	85	83	51	7	1	0
0	0	42	79	80	79	14	7	1	0
0	0	8	47	80	73	19	6	1	0



0 0 0 0 0 0 0 0 0 0  
CONCENTRATION

NUMBER OF TIME STEPS = 1  
DELTA T = .15779E+09  
TIME(SECONDS) = .15779E+09  
CHEM.TIME(SECONDS) = .10180E+09  
CHEM.TIME(DAYS) = .11782E+04  
TIME(YEARS) = .50000E+01  
CHEM.TIME(YEARS) = .32258E+01  
NO. MOVES COMPLETED = 320

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	2	4	29	95	3	0	0
0	0	20	32	47	90	93	15	0	0
0	0	58	79	86	90	88	9	1	0
0	0	62	83	85	84	45	7	1	0
0	0	42	80	76	81	15	7	1	0
0	0	8	48	78	73	18	7	1	0
0	0	0	0	0	0	0	0	0	0

CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
DELTA T = .15779E+09  
TIME(SECONDS) = .15779E+09  
CHEM.TIME(SECONDS) = .10180E+09  
CHEM.TIME(DAYS) = .11782E+04  
TIME(YEARS) = .50000E+01  
CHEM.TIME(YEARS) = .32258E+01  
NO. MOVES COMPLETED = 320

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	2	0	0	0
0	0	3	2	3	29	94	3	0	0
0	0	19	32	46	90	93	14	0	0
0	0	57	79	85	89	87	9	0	0
0	0	61	83	85	83	45	7	1	0
0	0	42	79	76	81	14	7	1	0
0	0	8	47	78	73	18	6	1	0
0	0	0	0	0	0	0	0	0	0

CONCENTRATION

NUMBER OF TIME STEPS = 1  
DELTA T = .15779E+09  
TIME(SECONDS) = .15779E+09  
CHEM.TIME(SECONDS) = .10498E+09  
CHEM.TIME(DAYS) = .12150E+04



TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .33266E+01  
 NO. MOVES COMPLETED = 330

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	3	4	28	95	3	0	0
0	0	18	30	47	90	93	7	0	0
0	0	62	80	86	90	88	9	1	0
0	0	62	82	85	84	45	7	1	0
0	0	46	81	80	81	15	7	1	0
0	0	8	51	78	75	18	7	1	0
0	0	0	0	0	0	0	0	0	0

## CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .10498E+09  
 CHEM.TIME(DAYS) = .12150E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .33266E+01  
 NO. MOVES COMPLETED = 330

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	2	0	0	0
0	0	3	2	3	28	94	3	0	0
0	0	17	29	47	90	93	6	0	0
0	0	61	79	85	89	87	8	0	0
0	0	62	81	84	83	45	7	0	0
0	0	46	81	79	81	15	7	1	0
0	0	7	51	78	75	17	7	1	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .10816E+09  
 CHEM.TIME(DAYS) = .12519E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .34274E+01  
 NO. MOVES COMPLETED = 340

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0









HEAD (FT)	CONC. (MG/L)	OBS. WELL NO.	X	Y	N
		TIME (YEARS)			
		1	3	4	
					0
.0	.0	.000			1
23.7	.1	3.034			2
23.7	.0	3.044			3
23.7	.0	3.054			4
23.7	.0	3.065			5
23.7	.1	3.075			6
23.7	.1	3.085			7
23.7	.1	3.095			8
23.7	.0	3.105			9
23.7	.0	3.115			10
23.7	.0	3.125			11
23.7	.1	3.135			12
23.7	.1	3.145			13
23.7	.0	3.155			14
23.7	.0	3.165			15
23.7	.0	3.175			16
23.7	.0	3.185			17
23.7	.0	3.196			18
23.7	.0	3.206			19
23.7	.0	3.216			20
23.7	.1	3.226			21
23.7	.1	3.236			22
23.7	.1	3.246			



			23
23.7	.1	3.256	
			24
23.7	.0	3.266	
			25
23.7	.1	3.276	
			26
23.7	.1	3.286	
			27
23.7	.0	3.296	
			28
23.7	.0	3.306	
			29
23.7	.0	3.317	
			30
23.7	.1	3.327	
			31
23.7	.1	3.337	
			32
23.7	.1	3.347	
			33
23.7	.1	3.357	
			34
23.7	.1	3.367	
			35
23.7	.1	3.377	
			36
23.7	.1	3.387	
			37
23.7	.1	3.397	
			38
23.7	.0	3.407	
			39
23.7	.0	3.417	
			40
23.7	.1	3.427	
			41
23.7	.1	3.437	
			42
23.7	.1	3.448	
			43
23.7	.1	3.458	
			44
23.7	.1	3.468	
			45
23.7	.1	3.478	
			46
23.7	.1	3.488	
			47
23.7	.0	3.498	
			48
23.7	.0	3.508	



23.7	.0	3.518	49
23.7	.0	3.528	50
	OBS.WELL NO.	X	Y
HEAD (FT)	CONC. (MG/L)	TIME (YEARS)	N
	2	2	7
.0	.0	.000	0
-4.1	62.1	3.034	1
-4.1	64.7	3.044	2
-4.1	64.5	3.054	3
-4.1	64.3	3.065	4
-4.1	64.1	3.075	5
-4.1	63.9	3.085	6
-4.1	63.7	3.095	7
-4.1	66.9	3.105	8
-4.1	66.7	3.115	9
-4.1	66.5	3.125	10
-4.1	64.8	3.135	11
-4.1	64.6	3.145	12
-4.1	66.8	3.155	13
-4.1	68.2	3.165	14
-4.1	67.9	3.175	15
-4.1	66.7	3.185	16
-4.1	66.5	3.196	17
-4.1	68.1	3.206	18
-4.1	67.9	3.216	19
-4.1	57.6	3.226	20



-4.1	57.5	3.236	21
-4.1	57.5	3.246	22
-4.1	54.7	3.256	23
-4.1	57.4	3.266	24
-4.1	59.4	3.276	25
-4.1	59.3	3.286	26
-4.1	59.6	3.296	27
-4.1	62.1	3.306	28
-4.1	62.0	3.317	29
-4.1	61.9	3.327	30
-4.1	59.7	3.337	31
-4.1	59.6	3.347	32
-4.1	62.1	3.357	33
-4.1	62.0	3.367	34
-4.1	59.6	3.377	35
-4.1	59.5	3.387	36
-4.1	55.9	3.397	37
-4.1	55.9	3.407	38
-4.1	55.8	3.417	39
-4.1	55.7	3.427	40
-4.1	55.7	3.437	41
-4.1	55.6	3.448	42
-4.1	55.6	3.458	43
-4.1	55.5	3.468	44
-4.1	55.5	3.478	45
-4.1	56.9	3.488	46





				47
-4.1	58.8	3.498		48
-4.1	58.7	3.508		49
-4.1	59.1	3.518		50
-4.1	59.0	3.528		
	OBS.WELL NO.	X	Y	N
HEAD (FT)	CONC.(MG/L)	TIME (YEARS)		
	3	5	8	
				0
.0	.0	.000		1
8.9	84.0	3.034		2
8.9	84.1	3.044		3
8.9	84.1	3.054		4
8.9	84.1	3.065		5
8.9	84.2	3.075		6
8.9	84.1	3.085		7
8.9	84.0	3.095		8
8.9	83.8	3.105		9
8.9	83.7	3.115		10
8.9	83.7	3.125		11
8.9	83.7	3.135		12
8.9	83.6	3.145		13
8.9	83.6	3.155		14
8.9	83.6	3.165		15
8.9	83.7	3.175		16
8.9	83.7	3.185		17
8.9	83.8	3.196		18
8.9	83.9	3.206		



			19
8.9	83.9	3.216	
			20
8.9	84.0	3.226	
			21
8.9	84.1	3.236	
			22
8.9	84.1	3.246	
			23
8.9	84.1	3.256	
			24
8.9	84.1	3.266	
			25
8.9	84.1	3.276	
			26
8.9	84.1	3.286	
			27
8.9	84.0	3.296	
			28
8.9	84.0	3.306	
			29
8.9	84.0	3.317	
			30
8.9	83.9	3.327	
			31
8.9	83.9	3.337	
			32
8.9	83.9	3.347	
			33
8.9	83.9	3.357	
			34
8.9	83.9	3.367	
			35
8.9	83.9	3.377	
			36
8.9	83.9	3.387	
			37
8.9	83.9	3.397	
			38
8.9	83.9	3.407	
			39
8.9	84.0	3.417	
			40
8.9	84.0	3.427	
			41
8.9	83.9	3.437	
			42
8.9	83.9	3.448	
			43
8.9	85.4	3.458	
			44
8.9	84.1	3.468	



				45
8.9	81.8	3.478		46
8.9	82.3	3.488		47
8.9	83.0	3.498		48
8.9	84.4	3.508		49
8.9	84.4	3.518		50
8.9	84.0	3.528		
	OBS.WELL NO.	X	Y	N
HEAD (FT)	CONC. (MG/L)	TIME (YEARS)		
		4	8	9
				0
.0	.0	.000		1
7.6	1.3	3.034		2
7.6	1.3	3.044		3
7.6	1.3	3.054		4
7.6	1.2	3.065		5
7.6	1.3	3.075		6
7.6	1.3	3.085		7
7.6	1.3	3.095		8
7.6	1.3	3.105		9
7.6	1.3	3.115		10
7.6	1.3	3.125		11
7.6	1.3	3.135		12
7.6	1.3	3.145		13
7.6	1.3	3.155		14
7.6	1.3	3.165		15
7.6	1.3	3.175		16
7.6	1.3	3.185		



			17
7.6	1.3	3.196	18
7.6	1.2	3.206	19
7.6	1.2	3.216	20
7.6	1.3	3.226	21
7.6	1.3	3.236	22
7.6	1.2	3.246	23
7.6	1.2	3.256	24
7.6	1.2	3.266	25
7.6	1.2	3.276	26
7.6	1.2	3.286	27
7.6	1.2	3.296	28
7.6	1.2	3.306	29
7.6	1.2	3.317	30
7.6	1.2	3.327	31
7.6	1.2	3.337	32
7.6	1.2	3.347	33
7.6	1.2	3.357	34
7.6	1.2	3.367	35
7.6	1.2	3.377	36
7.6	1.2	3.387	37
7.6	1.2	3.397	38
7.6	1.2	3.407	39
7.6	1.2	3.417	40
7.6	1.2	3.427	41
7.6	1.2	3.437	42
7.6	1.2	3.448	













## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .12089E+09  
 CHEM.TIME(DAYS) = .13991E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .38306E+01  
 NO. MOVES COMPLETED = 380

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	2	4	31	95	3	0	0
0	0	23	31	45	90	93	6	0	0
0	0	68	77	84	89	88	8	1	0
0	0	62	85	84	82	61	8	1	0
0	0	53	81	83	80	17	6	1	0
0	0	7	59	80	72	25	8	2	0
0	0	0	0	0	0	0	0	0	0

## CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .12089E+09  
 CHEM.TIME(DAYS) = .13991E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .38306E+01  
 NO. MOVES COMPLETED = 380

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	3	0	0	0
0	0	2	2	3	31	94	2	0	0
0	0	22	30	44	89	93	6	0	0
0	0	68	76	84	89	87	8	0	0
0	0	62	84	84	81	61	7	1	0
0	0	52	80	83	79	16	6	1	0
0	0	7	58	79	71	24	7	1	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .12407E+09  
 CHEM.TIME(DAYS) = .14360E+04  
 TIME(YEARS) = .50000E+01



CHEM.TIME(YEARS) = .39314E+01  
 NO. MOVES COMPLETED = 390

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	3	4	32	95	3	0	0
0	0	15	30	40	90	93	16	0	0
0	0	70	78	85	90	88	8	1	0
0	0	61	84	86	84	60	8	1	0
0	0	48	81	82	79	13	7	1	0
0	0	7	59	81	73	21	7	2	0
0	0	0	0	0	0	0	0	0	0

CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .12407E+09  
 CHEM.TIME(DAYS) = .14360E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .39314E+01  
 NO. MOVES COMPLETED = 390

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	3	0	0	0
0	0	3	2	3	32	94	2	0	0
0	0	14	30	40	90	93	15	0	0
0	0	69	77	84	89	88	8	0	0
0	0	60	84	85	84	59	7	1	0
0	0	47	80	82	78	13	6	1	0
0	0	7	58	80	73	21	6	1	0
0	0	0	0	0	0	0	0	0	0

CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .12725E+09  
 CHEM.TIME(DAYS) = .14728E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .40322E+01  
 NO. MOVES COMPLETED = 400

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	2	4	37	95	3	0	0





0	0	13	37	36	90	94	7	0	0
0	0	72	79	85	90	88	9	1	0
0	0	62	84	85	84	51	8	1	0
0	0	48	80	78	80	15	7	1	0
0	0	12	59	80	73	19	7	1	0
0	0	0	0	0	0	0	0	0	0

HEAD (FT)	CONC. (MG/L)	OBS. WELL NO. TIME (YEARS)	X 3	Y 4	N
		1			
.0	.0	.000			0
23.7	.0	3.538			1
23.7	.0	3.548			2
23.7	.0	3.558			3
23.7	.0	3.569			4
23.7	.0	3.579			5
23.7	.0	3.589			6
23.7	.1	3.599			7
23.7	.1	3.609			8
23.7	.1	3.619			9
23.7	.0	3.629			10
23.7	.1	3.639			11
23.7	.1	3.649			12
23.7	.0	3.659			13
23.7	.0	3.669			14
23.7	.0	3.679			15
23.7	.0	3.690			16
23.7	.0	3.700			17
23.7	.0	3.710			18
					19



23.7	.0	3.720	20
23.7	.1	3.730	21
23.7	.0	3.740	22
23.7	.0	3.750	23
23.7	.0	3.760	24
23.7	.0	3.770	25
23.7	.0	3.780	26
23.7	.0	3.790	27
23.7	.0	3.800	28
23.7	.0	3.810	29
23.7	.0	3.821	30
23.7	.0	3.831	31
23.7	.1	3.841	32
23.7	.0	3.851	33
23.7	.0	3.861	34
23.7	.0	3.871	35
23.7	.0	3.881	36
23.7	.1	3.891	37
23.7	.0	3.901	38
23.7	.0	3.911	39
23.7	.0	3.921	40
23.7	.1	3.931	41
23.7	.1	3.942	42
23.7	.1	3.952	43
23.7	.0	3.962	44
23.7	.0	3.972	45



23.7	.0	3.982				
						46
23.7	.1	3.992				
						47
23.7	.1	4.002				
						48
23.7	.1	4.012				
						49
23.7	.0	4.022				
						50
23.7	.0	4.032				
						N
HEAD (FT)	CONC. (MG/L)	OBS. WELL NO.	X	Y		
		TIME (YEARS)				
		2	2	7		
						0
.0	.0	.000				1
-4.1	59.0	3.538				2
-4.1	60.9	3.548				3
-4.1	60.8	3.558				4
-4.1	61.4	3.569				5
-4.1	61.3	3.579				6
-4.1	62.1	3.589				7
-4.1	63.2	3.599				8
-4.1	63.1	3.609				9
-4.1	65.6	3.619				10
-4.1	65.4	3.629				11
-4.1	64.1	3.639				12
-4.1	64.0	3.649				13
-4.1	63.8	3.659				14
-4.1	65.0	3.669				15
-4.1	64.8	3.679				16
-4.1	65.9	3.690				17



-4.1	67.2	3.700	18
-4.1	67.1	3.710	19
-4.1	67.5	3.720	20
-4.1	67.3	3.730	21
-4.1	67.2	3.740	22
-4.1	67.0	3.750	23
-4.1	65.4	3.760	24
-4.1	65.3	3.770	25
-4.1	65.1	3.780	26
-4.1	65.0	3.790	27
-4.1	64.8	3.800	28
-4.1	64.6	3.810	29
-4.1	68.7	3.821	30
-4.1	68.2	3.831	31
-4.1	68.0	3.841	32
-4.1	67.8	3.851	33
-4.1	67.7	3.861	34
-4.1	68.9	3.871	35
-4.1	68.7	3.881	36
-4.1	68.5	3.891	37
-4.1	70.2	3.901	38
-4.1	70.0	3.911	39
-4.1	69.8	3.921	40
-4.1	69.6	3.931	41
-4.1	69.4	3.942	42
-4.1	69.2	3.952	43





-4.1	71.5	3.962				44
-4.1	71.3	3.972				45
-4.1	71.1	3.982				46
-4.1	70.0	3.992				47
-4.1	69.8	4.002				48
-4.1	71.4	4.012				49
-4.1	72.2	4.022				50
-4.1	72.0	4.032				N
	OBS.	WELL NO.	X	Y		
HEAD (FT)	CONC. (MG/L)	TIME (YEARS)				
		3	5	8		
.0	.0	.000				0
8.9	83.7	3.538				1
8.9	84.0	3.548				2
8.9	85.0	3.558				3
8.9	84.8	3.569				4
8.9	85.0	3.579				5
8.9	84.8	3.589				6
8.9	84.6	3.599				7
8.9	85.7	3.609				8
8.9	86.3	3.619				9
8.9	87.0	3.629				10
8.9	87.0	3.639				11
8.9	87.0	3.649				12
8.9	85.3	3.659				13
8.9	84.3	3.669				14
						15



8.9	82.6	3.679	16
8.9	82.5	3.690	17
8.9	81.5	3.700	18
8.9	80.7	3.710	19
8.9	80.4	3.720	20
8.9	79.9	3.730	21
8.9	79.2	3.740	22
8.9	79.3	3.750	23
8.9	78.8	3.760	24
8.9	79.0	3.770	25
8.9	78.6	3.780	26
8.9	79.6	3.790	27
8.9	80.3	3.800	28
8.9	80.8	3.810	29
8.9	81.0	3.821	30
8.9	81.6	3.831	31
8.9	82.1	3.841	32
8.9	82.5	3.851	33
8.9	83.2	3.861	34
8.9	83.4	3.871	35
8.9	83.6	3.881	36
8.9	84.1	3.891	37
8.9	84.1	3.901	38
8.9	84.1	3.911	39
8.9	84.1	3.921	40
8.9	84.2	3.931	41



8.9	84.1	3.942				42
8.9	84.0	3.952				43
8.9	83.9	3.962				44
8.9	83.7	3.972				45
8.9	83.7	3.982				46
8.9	83.7	3.992				47
8.9	83.7	4.002				48
8.9	83.6	4.012				49
8.9	83.6	4.022				50
8.9	83.7	4.032				
	OBS.	WELL NO.	X	Y		N
HEAD (FT)	CONC. (MG/L)	TIME (YEARS)				
		4	8	9		
						0
.0	.0	.000				1
7.6	1.3	3.538				2
7.6	1.2	3.548				3
7.6	1.2	3.558				4
7.6	1.2	3.569				5
7.6	1.3	3.579				6
7.6	1.3	3.589				7
7.6	1.3	3.599				8
7.6	1.3	3.609				9
7.6	1.3	3.619				10
7.6	1.3	3.629				11
7.6	1.3	3.639				12
7.6	1.3	3.649				13



7.6	1.3	3.659	14
7.6	1.3	3.669	15
7.6	1.4	3.679	16
7.6	1.4	3.690	17
7.6	1.4	3.700	18
7.6	1.4	3.710	19
7.6	1.4	3.720	20
7.6	1.4	3.730	21
7.6	1.4	3.740	22
7.6	1.3	3.750	23
7.6	1.4	3.760	24
7.6	1.4	3.770	25
7.6	1.4	3.780	26
7.6	1.4	3.790	27
7.6	1.4	3.800	28
7.6	1.3	3.810	29
7.6	1.3	3.821	30
7.6	1.3	3.831	31
7.6	1.3	3.841	32
7.6	1.3	3.851	33
7.6	1.3	3.861	34
7.6	1.3	3.871	35
7.6	1.3	3.881	36
7.6	1.3	3.891	37
7.6	1.3	3.901	38
7.6	1.3	3.911	39





7.6	1.2	3.921	
			40
7.6	1.3	3.931	
			41
7.6	1.3	3.942	
			42
7.6	1.3	3.952	
			43
7.6	1.3	3.962	
			44
7.6	1.3	3.972	
			45
7.6	1.3	3.982	
			46
7.6	1.3	3.992	
			47
7.6	1.3	4.002	
			48
7.6	1.3	4.012	
			49
7.6	1.3	4.022	
			50
7.6	1.3	4.032	

CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME (SECONDS) = .15779E+09  
 CHEM.TIME (SECONDS) = .13043E+09  
 CHEM.TIME (DAYS) = .15096E+04  
 TIME (YEARS) = .50000E+01  
 CHEM.TIME (YEARS) = .41331E+01  
 NO. MOVES COMPLETED = 410

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	3	4	31	95	9	0	0
0	0	13	30	45	90	93	7	0	0
0	0	65	80	86	90	88	8	1	0
0	0	68	83	85	84	48	7	1	0
0	0	51	82	80	81	15	7	1	0
0	0	12	61	77	75	18	7	1	0
0	0	0	0	0	0	0	0	0	0

CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME (SECONDS) = .15779E+09  
 CHEM.TIME (SECONDS) = .13043E+09  
 CHEM.TIME (DAYS) = .15096E+04



TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .41331E+01  
 NO. MOVES COMPLETED = 410

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	3	0	0	0
0	0	3	2	3	30	94	9	0	0
0	0	12	30	45	89	93	6	0	0
0	0	65	79	85	90	87	8	0	0
0	0	67	82	85	84	48	7	1	0
0	0	51	81	79	81	15	7	1	0
0	0	11	61	77	74	17	6	1	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .13361E+09  
 CHEM.TIME(DAYS) = .15464E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .42339E+01  
 NO. MOVES COMPLETED = 420

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	2	4	34	95	3	0	0
0	0	20	34	38	90	93	15	0	0
0	0	65	80	86	90	88	8	1	0
0	0	67	84	85	84	51	8	1	0
0	0	52	82	79	82	16	7	1	0
0	0	12	62	79	76	18	7	1	0
0	0	0	0	0	0	0	0	0	0

## CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .13361E+09  
 CHEM.TIME(DAYS) = .15464E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .42339E+01  
 NO. MOVES COMPLETED = 420

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	3	0	0	0



0	0	3	2	3	33	94	3	0	0
0	0	19	33	38	90	93	15	0	0
0	0	64	79	85	89	87	8	0	0
0	0	67	83	84	83	51	7	0	0
0	0	51	82	79	81	15	7	1	0
0	0	11	61	79	75	18	6	1	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .13679E+09  
 CHEM.TIME(DAYS) = .15832E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .43347E+01  
 NO. MOVES COMPLETED = 430

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	4	0	0	0
0	0	2	2	5	44	87	3	0	0
0	0	21	26	53	82	85	8	0	0
0	0	61	80	86	90	88	13	1	0
0	0	70	83	85	82	64	9	1	0
0	0	49	82	79	81	27	7	1	0
0	0	11	64	79	77	17	7	1	0
0	0	0	0	0	0	0	0	0	0

## CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .13679E+09  
 CHEM.TIME(DAYS) = .15832E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .43347E+01  
 NO. MOVES COMPLETED = 430

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	2	1	4	43	86	3	0	0
0	0	20	26	53	81	85	8	0	0
0	0	61	79	85	89	87	13	0	0
0	0	69	83	85	81	64	9	1	0
0	0	48	81	79	81	27	7	1	0
0	0	11	64	79	77	17	7	1	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION



NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .13997E+09  
 CHEM.TIME(DAYS) = .16201E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .44355E+01  
 NO. MOVES COMPLETED = 440

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	2	3	0	0	0
0	0	3	2	5	30	93	3	0	0
0	0	21	28	53	84	87	25	1	0
0	0	65	80	82	83	68	10	1	0
0	0	68	84	88	85	51	12	1	0
0	0	53	81	82	76	39	8	1	0
0	0	11	64	78	71	17	7	1	0
0	0	0	0	0	0	0	0	0	0

## CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .13997E+09  
 CHEM.TIME(DAYS) = .16201E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .44355E+01  
 NO. MOVES COMPLETED = 440

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	2	2	4	29	93	3	0	0
0	0	20	27	53	83	86	25	0	0
0	0	65	79	82	82	67	10	0	0
0	0	67	84	87	85	51	11	1	0
0	0	53	81	81	75	38	8	1	0
0	0	11	64	78	70	17	7	1	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .14315E+09  
 CHEM.TIME(DAYS) = .16569E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .45363E+01





NO. MOVES COMPLETED = 450

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	2	4	28	95	3	0	0
0	0	14	25	46	89	93	7	1	0
0	0	68	77	80	86	78	8	1	0
0	0	67	85	87	83	43	8	1	0
0	0	54	81	83	77	29	7	1	0
0	0	11	66	79	72	26	7	1	0
0	0	0	0	0	0	0	0	0	0

HEAD (FT)	CONC. (MG/L)	OBS. WELL NO.	X	Y	N
		TIME (YEARS)			
		1	3	4	
					0
.0	.0	.000			1
23.7	.0	4.042			2
23.7	.0	4.052			3
23.7	.0	4.062			4
23.7	.0	4.073			5
23.7	.1	4.083			6
23.7	.1	4.093			7
23.7	.1	4.103			8
23.7	.1	4.113			9
23.7	.0	4.123			10
23.7	.1	4.133			11
23.7	.1	4.143			12
23.7	.0	4.153			13
23.7	.0	4.163			14
23.7	.0	4.173			15
23.7	.1	4.183			



			16
23.7	.1	4.194	17
23.7	.1	4.204	18
23.7	.1	4.214	19
23.7	.1	4.224	20
23.7	.1	4.234	21
23.7	.1	4.244	22
23.7	.1	4.254	23
23.7	.1	4.264	24
23.7	.0	4.274	25
23.7	.1	4.284	26
23.7	.1	4.294	27
23.7	.1	4.304	28
23.7	.1	4.315	29
23.7	.1	4.325	30
23.7	.1	4.335	31
23.7	.1	4.345	32
23.7	.0	4.355	33
23.7	.0	4.365	34
23.7	.0	4.375	35
23.7	.0	4.385	36
23.7	.0	4.395	37
23.7	.0	4.405	38
23.7	.0	4.415	39
23.7	.0	4.425	40
23.7	.0	4.435	41
23.7	.1	4.446	



			42
23.7	.1	4.456	
			43
23.7	.1	4.466	
			44
23.7	.1	4.476	
			45
23.7	.1	4.486	
			46
23.7	.1	4.496	
			47
23.7	.1	4.506	
			48
23.7	.1	4.516	
			49
23.7	.0	4.526	
			50
23.7	.0	4.536	
	OBS.WELL NO.	X	Y
HEAD (FT)	CONC. (MG/L)	TIME (YEARS)	N
	2	2	7
			0
.0	.0	.000	
			1
-4.1	71.1	4.042	
			2
-4.1	70.9	4.052	
			3
-4.1	72.0	4.062	
			4
-4.1	71.7	4.073	
			5
-4.1	63.9	4.083	
			6
-4.1	63.8	4.093	
			7
-4.1	63.7	4.103	
			8
-4.1	61.5	4.113	
			9
-4.1	63.5	4.123	
			10
-4.1	65.0	4.133	
			11
-4.1	64.9	4.143	
			12
-4.1	64.7	4.153	
			13
-4.1	66.7	4.163	



			14
-4.1	66.5	4.173	
			15
-4.1	66.4	4.183	
			16
-4.1	64.8	4.194	
			17
-4.1	64.7	4.204	
			18
-4.1	66.7	4.214	
			19
-4.1	66.5	4.224	
			20
-4.1	64.7	4.234	
			21
-4.1	64.5	4.244	
			22
-4.1	61.8	4.254	
			23
-4.1	61.7	4.264	
			24
-4.1	61.6	4.274	
			25
-4.1	61.5	4.284	
			26
-4.1	61.4	4.294	
			27
-4.1	61.3	4.304	
			28
-4.1	61.2	4.315	
			29
-4.1	61.1	4.325	
			30
-4.1	61.0	4.335	
			31
-4.1	62.2	4.345	
			32
-4.1	63.8	4.355	
			33
-4.1	63.7	4.365	
			34
-4.1	64.0	4.375	
			35
-4.1	63.9	4.385	
			36
-4.1	63.7	4.395	
			37
-4.1	65.2	4.405	
			38
-4.1	65.1	4.415	
			39
-4.1	65.6	4.425	





				40
-4.1	65.4	4.435		41
-4.1	66.1	4.446		42
-4.1	67.0	4.456		43
-4.1	66.8	4.466		44
-4.1	68.9	4.476		45
-4.1	68.8	4.486		46
-4.1	67.9	4.496		47
-4.1	67.7	4.506		48
-4.1	67.5	4.516		49
-4.1	68.4	4.526		50
-4.1	68.2	4.536		N
HEAD (FT)	OBS. WELL NO.	X	Y	
	CONC. (MG/L)	TIME (YEARS)		
	3	5	8	
				0
.0	.0	.000		1
8.9	83.7	4.042		2
8.9	83.9	4.052		3
8.9	83.9	4.062		4
8.9	83.9	4.073		5
8.9	84.0	4.083		6
8.9	84.1	4.093		7
8.9	84.1	4.103		8
8.9	84.1	4.113		9
8.9	84.1	4.123		10
8.9	84.1	4.133		11
8.9	84.1	4.143		



12

8.9	84.1	4.153
-----	------	-------

13

8.9	84.0	4.163
-----	------	-------

14

8.9	84.0	4.173
-----	------	-------

15

8.9	83.9	4.183
-----	------	-------

16

8.9	83.9	4.194
-----	------	-------

17

8.9	83.9	4.204
-----	------	-------

18

8.9	83.9	4.214
-----	------	-------

19

8.9	83.9	4.224
-----	------	-------

20

8.9	83.9	4.234
-----	------	-------

21

8.9	83.9	4.244
-----	------	-------

22

8.9	83.9	4.254
-----	------	-------

23

8.9	83.9	4.264
-----	------	-------

24

8.9	84.0	4.274
-----	------	-------

25

8.9	84.0	4.284
-----	------	-------

26

8.9	83.9	4.294
-----	------	-------

27

8.9	83.9	4.304
-----	------	-------

28

8.9	85.5	4.315
-----	------	-------

29

8.9	84.1	4.325
-----	------	-------

30

8.9	81.8	4.335
-----	------	-------

31

8.9	82.3	4.345
-----	------	-------

32

8.9	83.0	4.355
-----	------	-------

33

8.9	84.4	4.365
-----	------	-------

34

8.9	84.4	4.375
-----	------	-------

35

8.9	84.0	4.385
-----	------	-------

36

8.9	83.7	4.395
-----	------	-------

37

8.9	84.0	4.405
-----	------	-------



				38
8.9	85.1	4.415		39
8.9	84.9	4.425		40
8.9	85.0	4.435		41
8.9	84.8	4.446		42
8.9	84.6	4.456		43
8.9	85.8	4.466		44
8.9	86.3	4.476		45
8.9	87.0	4.486		46
8.9	87.0	4.496		47
8.9	87.0	4.506		48
8.9	85.3	4.516		49
8.9	84.3	4.526		50
8.9	82.6	4.536		N
HEAD (FT)	OBS.WELL NO.	X	Y	
	CONC.(MG/L)	TIME (YEARS)		
	4	8	9	
				0
.0	.0	.000		1
7.6	1.3	4.042		2
7.6	1.3	4.052		3
7.6	1.2	4.062		4
7.6	1.2	4.073		5
7.6	1.3	4.083		6
7.6	1.3	4.093		7
7.6	1.2	4.103		8
7.6	1.2	4.113		9
7.6	1.2	4.123		



			10
7.6	1.2	4.133	11
7.6	1.2	4.143	12
7.6	1.2	4.153	13
7.6	1.2	4.163	14
7.6	1.2	4.173	15
7.6	1.2	4.183	16
7.6	1.2	4.194	17
7.6	1.2	4.204	18
7.6	1.2	4.214	19
7.6	1.2	4.224	20
7.6	1.2	4.234	21
7.6	1.2	4.244	22
7.6	1.2	4.254	23
7.6	1.2	4.264	24
7.6	1.2	4.274	25
7.6	1.2	4.284	26
7.6	1.2	4.294	27
7.6	1.2	4.304	28
7.6	1.2	4.315	29
7.6	1.2	4.325	30
7.6	1.2	4.335	31
7.6	1.2	4.345	32
7.6	1.2	4.355	33
7.6	1.2	4.365	34
7.6	1.3	4.375	35
7.6	1.2	4.385	









## CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .14634E+09  
 CHEM.TIME(DAYS) = .16937E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .46371E+01  
 NO. MOVES COMPLETED = 460

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	2	0	0	0
0	0	3	2	3	29	94	9	0	0
0	0	12	20	46	89	92	7	0	0
0	0	68	77	83	88	82	8	0	0
0	0	69	85	85	78	57	7	1	0
0	0	56	81	83	83	17	7	1	0
0	0	10	66	79	71	26	7	1	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .14952E+09  
 CHEM.TIME(DAYS) = .17305E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .47379E+01  
 NO. MOVES COMPLETED = 470

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	2	3	30	95	3	0	0
0	0	17	32	47	90	93	14	0	0
0	0	71	77	84	89	88	9	1	0
0	0	68	84	86	84	51	7	1	0
0	0	51	82	82	78	14	6	1	0
0	0	10	67	80	73	23	7	2	0
0	0	0	0	0	0	0	0	0	0

## CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .14952E+09  
 CHEM.TIME(DAYS) = .17305E+04  
 TIME(YEARS) = .50000E+01



CHEM.TIME(YEARS) = .47379E+01  
 NO. MOVES COMPLETED = 470

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	2	0	0	0
0	0	3	2	3	29	94	3	0	0
0	0	16	31	47	89	93	13	0	0
0	0	71	76	84	89	87	8	0	0
0	0	68	84	85	83	50	7	1	0
0	0	50	82	82	78	14	6	1	0
0	0	10	66	79	73	23	7	1	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .15270E+09  
 CHEM.TIME(DAYS) = .17673E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .48387E+01  
 NO. MOVES COMPLETED = 480

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	3	4	30	95	3	0	0
0	0	18	30	47	90	93	7	0	0
0	0	73	79	85	90	88	9	1	0
0	0	63	83	86	84	52	8	1	0
0	0	51	82	80	79	14	7	1	0
0	0	16	67	81	74	20	6	1	0
0	0	0	0	0	0	0	0	0	0

## CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .15270E+09  
 CHEM.TIME(DAYS) = .17673E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .48387E+01  
 NO. MOVES COMPLETED = 480

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	2	0	0	0
0	0	3	2	3	29	94	3	0	0



0	0	18	29	47	89	93	6	0	0
0	0	73	79	85	90	87	8	0	0
0	0	62	83	85	83	51	7	1	0
0	0	51	81	80	79	14	7	1	0
0	0	15	66	80	73	19	6	1	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .15588E+09  
 CHEM.TIME(DAYS) = .18042E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .49395E+01  
 NO. MOVES COMPLETED = 490

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	3	4	29	95	3	0	0
0	0	21	33	47	90	93	15	0	0
0	0	67	79	86	90	88	9	1	0
0	0	69	84	85	84	45	7	1	0
0	0	51	82	76	81	15	7	1	0
0	0	15	67	78	73	18	7	1	0
0	0	0	0	0	0	0	0	0	0

## CHANGE IN CONCENTRATION

NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .15588E+09  
 CHEM.TIME(DAYS) = .18042E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .49395E+01  
 NO. MOVES COMPLETED = 490

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	2	0	0	0
0	0	3	2	3	29	94	3	0	0
0	0	20	32	46	90	93	14	0	0
0	0	66	79	85	89	87	9	0	0
0	0	69	83	85	83	45	7	1	0
0	0	51	81	76	81	14	7	1	0
0	0	15	67	78	73	18	6	1	0
0	0	0	0	0	0	0	0	0	0

## CONCENTRATION





NUMBER OF TIME STEPS = 1  
 DELTA T = .15779E+09  
 TIME(SECONDS) = .15779E+09  
 CHEM.TIME(SECONDS) = .15779E+09  
 CHEM.TIME(DAYS) = .18263E+04  
 TIME(YEARS) = .50000E+01  
 CHEM.TIME(YEARS) = .50000E+01  
 NO. MOVES COMPLETED = 496

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	3	0	0	0
0	0	3	2	4	29	95	3	0	0
0	0	12	23	52	90	93	14	0	0
0	0	67	80	86	90	88	9	1	0
0	0	70	83	85	84	52	7	1	0
0	0	55	82	80	81	15	7	1	0
0	0	15	68	78	75	18	7	1	0
0	0	0	0	0	0	0	0	0	0

HEAD (FT)	CONC. (MG/L)	OBS.WELL NO. TIME (YEARS)	X	Y	N
		1	3	4	
					0
.0	.0	.000			1
23.7	.1	4.546			2
23.7	.0	4.556			3
23.7	.0	4.567			4
23.7	.0	4.577			5
23.7	.1	4.587			6
23.7	.0	4.597			7
23.7	.0	4.607			8
23.7	.0	4.617			9
23.7	.0	4.627			10
23.7	.0	4.637			11
23.7	.0	4.647			12



23.7	.0	4.657	13
23.7	.0	4.667	14
23.7	.0	4.677	15
23.7	.0	4.687	16
23.7	.1	4.698	17
23.7	.1	4.708	18
23.7	.0	4.718	19
23.7	.0	4.728	20
23.7	.0	4.738	21
23.7	.1	4.748	22
23.7	.0	4.758	23
23.7	.0	4.768	24
23.7	.0	4.778	25
23.7	.1	4.788	26
23.7	.1	4.798	27
23.7	.1	4.808	28
23.7	.0	4.819	29
23.7	.0	4.829	30
23.7	.0	4.839	31
23.7	.1	4.849	32
23.7	.1	4.859	33
23.7	.1	4.869	34
23.7	.0	4.879	35
23.7	.0	4.889	36
23.7	.0	4.899	37
23.7	.0	4.909	38



23.7	.0	4.919				
						39
23.7	.0	4.929				
						40
23.7	.1	4.940				
						41
23.7	.1	4.950				
						42
23.7	.1	4.960				
						43
23.7	.1	4.970				
						44
23.7	.0	4.980				
						45
23.7	.1	4.990				
						46
23.7	.1	5.000				
						N
HEAD (FT)	CONC. (MG/L)	OBS. WELL NO.	X	Y		
		TIME (YEARS)				
		2	2	7		
						0
.0	.0	.000				1
-4.1	69.1	4.546				2
-4.1	70.2	4.556				3
-4.1	70.0	4.567				4
-4.1	70.4	4.577				5
-4.1	70.2	4.587				6
-4.1	70.0	4.597				7
-4.1	69.8	4.607				8
-4.1	68.6	4.617				9
-4.1	68.4	4.627				10
-4.1	68.3	4.637				11
-4.1	68.1	4.647				12
-4.1	67.9	4.657				13
-4.1	67.7	4.667				14



-4.1	71.6	4.677	15
-4.1	71.2	4.687	16
-4.1	71.0	4.698	17
-4.1	70.8	4.708	18
-4.1	70.6	4.718	19
-4.1	71.6	4.728	20
-4.1	71.4	4.738	21
-4.1	71.2	4.748	22
-4.1	72.6	4.758	23
-4.1	72.4	4.768	24
-4.1	72.1	4.778	25
-4.1	71.9	4.788	26
-4.1	71.7	4.798	27
-4.1	71.5	4.808	28
-4.1	73.5	4.819	29
-4.1	73.3	4.829	30
-4.1	73.0	4.839	31
-4.1	72.2	4.849	32
-4.1	72.0	4.859	33
-4.1	73.2	4.869	34
-4.1	73.9	4.879	35
-4.1	73.6	4.889	36
-4.1	72.9	4.899	37
-4.1	72.7	4.909	38
-4.1	73.5	4.919	39
-4.1	73.3	4.929	40





-4.1	66.6	4.940				41
-4.1	66.5	4.950				42
-4.1	66.4	4.960				43
-4.1	64.5	4.970				44
-4.1	66.2	4.980				45
-4.1	67.4	4.990				46
-4.1	67.3	5.000				
	OBS.	WELL NO.	X	Y		N
HEAD (FT)	CONC. (MG/L)	TIME (YEARS)				
		3	5	8		
.0	.0	.000				0
8.9	82.5	4.546				1
8.9	81.5	4.556				2
8.9	80.7	4.567				3
8.9	80.4	4.577				4
8.9	79.9	4.587				5
8.9	79.2	4.597				6
8.9	79.3	4.607				7
8.9	78.8	4.617				8
8.9	79.0	4.627				9
8.9	78.6	4.637				10
8.9	79.7	4.647				11
8.9	80.3	4.657				12
8.9	80.8	4.667				13
8.9	81.0	4.677				14
8.9	81.6	4.687				15
						16



8.9	82.1	4.698	17
8.9	82.5	4.708	18
8.9	83.2	4.718	19
8.9	83.4	4.728	20
8.9	83.6	4.738	21
8.9	84.1	4.748	22
8.9	84.1	4.758	23
8.9	84.1	4.768	24
8.9	84.1	4.778	25
8.9	84.2	4.788	26
8.9	84.1	4.798	27
8.9	84.0	4.808	28
8.9	83.9	4.819	29
8.9	83.8	4.829	30
8.9	83.7	4.839	31
8.9	83.7	4.849	32
8.9	83.7	4.859	33
8.9	83.6	4.869	34
8.9	83.6	4.879	35
8.9	83.7	4.889	36
8.9	83.7	4.899	37
8.9	83.9	4.909	38
8.9	83.9	4.919	39
8.9	83.9	4.929	40
8.9	84.0	4.940	41
8.9	84.1	4.950	42



8.9	84.1	4.960				43
8.9	84.1	4.970				44
8.9	84.1	4.980				45
8.9	84.1	4.990				46
8.9	84.1	5.000				
	OBS.	WELL NO.	X	Y		N
HEAD (FT)	CONC. (MG/L)	TIME (YEARS)				
		4	8	9		
						0
.0	.0	.000				1
7.6	1.4	4.546				2
7.6	1.4	4.556				3
7.6	1.4	4.567				4
7.6	1.4	4.577				5
7.6	1.4	4.587				6
7.6	1.4	4.597				7
7.6	1.3	4.607				8
7.6	1.4	4.617				9
7.6	1.4	4.627				10
7.6	1.4	4.637				11
7.6	1.4	4.647				12
7.6	1.4	4.657				13
7.6	1.3	4.667				14
7.6	1.3	4.677				15
7.6	1.3	4.687				16
7.6	1.3	4.698				17
7.6	1.3	4.708				18



7.6	1.3	4.718	19
7.6	1.3	4.728	20
7.6	1.3	4.738	21
7.6	1.3	4.748	22
7.6	1.3	4.758	23
7.6	1.3	4.768	24
7.6	1.2	4.778	25
7.6	1.3	4.788	26
7.6	1.3	4.798	27
7.6	1.3	4.808	28
7.6	1.3	4.819	29
7.6	1.3	4.829	30
7.6	1.3	4.839	31
7.6	1.3	4.849	32
7.6	1.3	4.859	33
7.6	1.3	4.869	34
7.6	1.3	4.879	35
7.6	1.3	4.889	36
7.6	1.3	4.899	37
7.6	1.3	4.909	38
7.6	1.2	4.919	39
7.6	1.2	4.929	40
7.6	1.3	4.940	41
7.6	1.3	4.950	42
7.6	1.2	4.960	43
7.6	1.2	4.970	44





7.6	1.2	4.980	
7.6	1.2	4.990	45
7.6	1.2	5.000	46







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c.1 Evaluating a hazardous  
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